Paul

Final Report

of the

Pennsylvania Intercity High Speed Rail Passenger Commission

FEASIBILITY STUDY

The Federal Railway Administration provided the necessary funding to cover the cost of printing the High Speed Rail Commission's Final Report.

INDEX

APPENDICES

Pennsylvania High Speed Intercity Rail Passenger Commission

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* * *

RECOMMENDATIONS

1. Magnetic levitation should be the technology of choice for a cross-Pennsylvania high-speed rail system. Advanced steel-wheel technology should be considered an alternative strategy.

2. The General Assembly should draft legislation to authorize the first steps toward implementation of high-speed rail. (A sample of the consultants' suggested legislative language is included in this report.)

3. The Commonwealth should immediately authorize negotiations with the West German consortium, Transrapid International -- which has provided a written proposal that is contained in the appendix of this report -- concerning financial assistance, to determine the nature and extent of that financing and under what conditions it may be extended. This investigation should determine what the actual cost of the construction likely will be; what proportion of that cost likely will be covered, or whether all of it will be covered, by the proposed offshore financial assistance; and what sources are available to make up the difference, if any.

4. At the same time, issues that could not be covered in this commission's final phase of feasibility work should be addressed. Specifically, these include a more cost-effective alignment; a financing plan, including determination of details of the Transrapid proposal; an engineering analysis of the Transrapid proposal; and a final economic impact assessment.

5. If financial assistance fails to materialize to permit implementation of state-of-the-art technology, the Commonwealth should consider alternative strategies, such as building the system in stages or accepting a lower-cost (with correspondingly lower performance and less dramatic economic benefit) technology.*

*** While not a formal recommendation of the full commission, this opinion is held by a substantial minority of its members, and it reflects one implementation strategy proposed by the general engineering consultant. Although the commission consistently has favored higher technologies, it has never ruled out pursuit of cost-effective alternatives.**

SPEED SELLS

CHAIRMAN'S INTRODUCTION

When Japan inaugurated its 320-mile Shinkansen (New Trunk Line) between Tokyo and Osaka 25 years ago, overseas observers quickly concluded that High Speed Trains were not only technologically feasible, but they were also very desirable.

The passage of a quarter-century has only reinforced that opinion. Many nations now have their own fast trains, moving at sustained speeds -- rather than mere top speeds -- of 125 mph or more, on exclusive right-of-way with no other trains, no crossings and no interference of any kind.

In the ensuing quarter-century Shinkansen also proved that high speed passenger trains can be very profitable. By 1980, the system, then up to 640 miles, was producing net income of $1.3 billion per year. A similar record has been established since 1984 by the French TGV (*train a grande vitesse* or very high speed) between Paris and Lyons.

During that same 25 years, another transportation system, the Pennsylvania Turnpike, was being improved and extended until it reached a peak of excellent service to travelers.

Now, however, the 51-year-old Turnpike, like many of the nation's Interstate highways, is beginning to feel the crush of the transportation explosion. Airports, too, are approaching crisis.

According to *Time Magazine*, "Gridlock has gripped America, threatening to transform its highways and flyways into snarled barriers to progress." Almost every traveler can cite long delays at airports or on highways. In Pennsylvania, the General Assembly has given massive infusions of capital and approved many bond issues for infrastructure, but problems still exist for the Pennsylvania Turnpike and major airports.

High Speed Rail will provide a solution

Even without traffic jams or airport delays, travel between Pennsylvania's major cities takes considerable time, at least seven hours by Turnpike and Amtrak, three to five hours by air if travel to and from airports and "airport dwell" are considered. (Chicago's O'Hare has more than 12 million hours of passenger delay per year. That's the equivalent of **1,400 people standing idle around the clock all year, at the airport**). Pennsylvania's airports aren't that bad, but they are headed that way. According to media reports, the $567 million improvement of the Greater Pittsburgh Airport will not add one additional landing slot. With related highways, the final costs are expected to exceed $1 billion.

The four-year, $4 million study by our highly-professional consultant team (led by Parsons Brinckerhoff Gannett Fleming and including other highly-respected firms) proves that this new mode of transportation across Pennsylvania is not only technically feasible, but would also be the best way to fight highway and air gridlock, while protecting the environment and creating tens of thousands of jobs. It would pump billions into the state's economy, spark countless opportunities for real estate development and boost the Commonwealth's state tax revenue by hundreds of millions of dollars.

Such a super-railroad, able to move mail, packages and millions of riders a year between Downtown Philadelphia and Downtown Pittsburgh -- with eight intermediate stops -- in two hours, would also position Pennsylvania to export high technology railroading (or magnetic levitation systems) to other states and countries. It will be the first leg of a system that eventually will connect Philadelphia and the East Coast with Chicago.

Although work by the Commission's consultant team was halted in July, 1987, before the final tasks were completed, this Final Report is based on the extensive solid data accumulated by the consultants, including the finest Market Demand (Ridership) Study ever produced in the United States. The good news is that since then, conditions have improved for financing high

speed rail. Increases in travel, the threat of gridlock and environmental considerations are bringing heavy pressure on transportation leaders and planners, and, as a result, High Speed Rail is becoming an attractive alternative.

The three major changes are:

1. High Speed Rail costs now compare favorably with other modes,
2. It is profitable, and
3. New Federal legislation permits use of tax-free industrial revenue bonds for High Speed Rail, placing this mode on an equal basis with other transportation systems.

The Federal Highway System estimates the cost of a mile of new expressway in 1985 dollars is $43 million in an urban area and $11 million countryside. By comparison, High Speed Rail can be built for between $15 and $19 million per mile, according to Federal Railroad Administrator John Riley. And rail has a far higher carrying capacity on a much smaller volume of land. In addition, former freight rail right-of-way can be used in some places, reducing time and cost of condemnation, Riley said. According to the TGV Company and Transrapid International (German maglev) the Pennsylvania system can be built for even less, due to new technology and the fact that no tunnels will be needed. Thus, costs have fallen since our consultants made the estimates in this report. Obviously, new cost estimates are needed.

High Speed Rail compares even more favorably with current airport development costs. The controversial new airport under discussion for Denver is estimated to cost $2.8 billion. New York City has allocated $2.5 billion for an airport-modernization program that will only renew the existing capital plant without substantially raising its ability to handle increased passenger loads. High Speed Rail has an additional major benefit: it adds very substantial passenger-carrying capacity without environmental degradation. HSR trains use clean, electric power; emit no fumes; make very little noise and do their work on very small amounts of land. The typical right-of-way is about the width of a two-lane highway. Magnetic levitation vehicles are usually on an elevated guideway. Farmers can cultivate the earth underneath.

On January 5, 1989, the French announced that the original TGV route between Paris and Lyons has been earning very substantial profits.

A *New York Times* story said "Last year the Paris-Lyons line carried 17 million passengers and earned more than $100 million on $681 million in revenues," wrote reporter Steven Greenhouse. The *Times* said the Paris-Lyons line, opened in 1981 at a cost of $2 billion, is expected to pay off its infrastructure costs in 10 years instead of the originally projected 15. Speed sells.

The third major development, Federal legislation, occurred at 2 a.m. Saturday, October 22, 1988, when Congress approved legislation designed to give High Speed Rail parity with other transportation modes. It was one of the very last items passed by the 100th Congress.

This legislation will transform High Speed Rail dreams into concrete and steel and will enable Pennsylvania to renew its effort in this field, thus helping us to meet the rapidly escalating demands of the people for better transportation and mobility. Specifically, this legislation brings Federal recognition and support for High Speed Rail, as well as providing a financial incentive for public/private partnerships to build these systems.

The new Federal law permits High Speed Rail systems in the U.S. to be built with private money. It qualifies HSR infrastructure to be financed through the issuance of the same tax-free municipal bonds historically used to fund such other valuable public works as airports, docks, water and sewer systems, bridges and tunnels, expressway and tollways. Essentially, the law gives HSR some parity with competing modes of transportation by giving it access to the same infrastructure-financing mechanism, something intercity rail has never had before. In return for forgoing a relatively modest volume of tax receipts from bondholder dividends, government gains a new transportation resource that promises to save many times more in tax money than otherwise would have been spent to fund more expensive and less efficient forms of transportation.

Pennsylvania:
<u>Magnetic Levitation System Recommended</u>

The Pennsylvania Intercity High Speed Rail Passenger Commission, in one of its last official acts, voted for magnetic levitation for Pennsylvania as its first choice.

Transrapid International, the German developer of maglev, submitted a proposal for a Harrisburg-Pittsburgh maglev link, to be used in conjunction with an upgraded steel wheel system between Philadelphia and Harrisburg.

An interpolation was made from the Market Demand (Ridership) Forecasts for the combination of rail (Philadelphia-Harrisburg) and magnetic levitation (Harrisburg-Pittsburgh) taking into account the across-platform transfer at Harrisburg and an additional stop at Lewistown. The net result was approximately a two percent ridership reduction from the forecast for a single mode system. It is necessary to have verification of these estimates.

Magnetic levitation vehicles are lifted and propelled along and above a guideway by a wave of magnetic energy. They actually are flying, but because they surround the guideway, they cannot "derail." On December 21, 1979, an unmanned Japanese maglev vehicle reached 321 mph, and on December 11, 1987, a German maglev with passengers on board reached 252 mph. This was the same vehicle that members of the Pennsylvania commission rode two years earlier.

Today, new speed records are being established almost every month. But there is another "race." It is a competition between a number of American states to determine which will be first to have a high speed rail system. The winner undoubtedly will reap many economic benefits, but the others will also gain economic rewards.

A comprehensive Financial Plan based on these developments of the past year and on the solid facts developed by our distinguished team of consultants will be both realistic and achievable.

My thanks and appreciation to the members and former members of the Commission, who freely gave their time and effort without compensation, and to the hard-working staff, consultants and oversignt consultants. Thanks also to the Pennsylvania General Assembly, the Federal Railroad Administration and the West German Government and Industry Consortium for financing this feasibility study. This has truly been a labor of love.

Representative Richard A. Geist
Commission Chairman

February 22, 1989

BACKGROUND

On December 22, 1981, Act 144 was signed into law, authorizing creation of an independent, bipartisan commission to conduct a feasibility study for high-speed (up to 250 mph) passenger-train service between Philadelphia and Pittsburgh, with intermediate stations at Great Valley/Paoli, Lancaster, Harrisburg, Altoona, Johnstown and Greensburg. Later, the commission added State College and/or Lewistown to the list.

The commission was charged with assessing the following issues:

- Need and demand for high-speed rail passenger service.
- Construction costs and available technologies.
- Possible location and extent of specific routes to be serviced.
- Economic impacts of construction and operation.
- Financing options.
- Local issues.

The engineering firms of Parsons Brinckerhoff Quade & Douglas of Philadelphia and New York City and Gannett Fleming Transportation Engineers of Camp Hill, PA, formed a joint venture, known as Parsons Brinckerhoff/Gannett Fleming, or PBGF, to conduct the feasibility study. STV Engineers of Pottstown, PA and New York City served as oversight consultant to cross-check PBGF's assumptions and analyses. More than $4.2 million in state, federal and West German grants was spent on the study, as follows:

- $3,832,000 in state appropriations, as follows:
  - $850,000 in 1981
  - $1.6 million in 1984
  - $882,000 in 1985
  - $500,000 in 1986
- $384,000 in three federal grants
- $25,000 in a grant from the West German government and a private West German technology consortium

With their subcontractors, PBGF and STV worked from August 1983 to July, 1987, when project funding abruptly terminated. This report summarizes the work of PBGF and STV as well as the contributions of French and West German engineers and suppliers who came to hold such faith in the prospects for high-speed Pennsylvania service that they offered, and continue to offer, technical and financial assistance to bring it to reality.

Definition of High-Speed Rail

High-speed rail passenger service as discussed in this study report means:

- Passenger trains operating at a minimum of 125 mph, and as high as 250 mph. These speeds would be maintained for significant intervals, not just in occasional spurts.

- New trackage dedicated exclusively to high-speed passenger service as a safety measure. Trains would not operate on freight trackage; in fact, the very technology of one option, magnetic levitation, precludes sharing trackage with conventional trains.

- As a further safety measure, the right-of-way would be "grade separated", meaning the there would be no highway grade crossings and no pedestrian crossings. Building bridges over the track or bridging the railroad over local roads would preserve patterns of motor-vehicle travel.

- Frequent departures, approximately hourly through the day from 6 a.m. to midnight.

- On-board services and amenities superior to those offered by conventional rail service or airlines, including characteristics of interior roominess and constraint-free surroundings. Certain services would be aimed specifically at business travelers -- for example, computer-communications systems.

- Clean, efficient, appealing stations that offer ticketing, baggage service and easy connections to other transportation modes. Most stations will be centrally located in the downtown areas of each city.

- Large parking facilities at stations to encourage the use of the automobile as feeder vehicle for intercity trips.

- A commitment to regular, orderly maintenance of trains, trackage, signals and stations to protect the system's reliability and performance.

Overview

What does high-speed rail offer Pennsylvanians?

For travelers --

- Safety
- Speed
- Frequency
- Convenience
- Reliability
- All-weather service

For the state's economy --

- Construction employment
- Expansion of tax base
- Real estate development near station sites
- Creation of a new, first-in-the-nation industry
- Support for the state's established railroad-supply industry

For all Pennsylvanians --

- Environmental protection
- Sound land-use policies
- Improved mobility
- Boost in the state's image as a place to live and do business
- An end to cultural, political and economic polarization between eastern and western Pennsylvania.

Why is Pennsylvania a candidate for high-speed rail?

- The state has two large cities about 300 miles apart, with a capital city and several significant smaller cities in between. The proposed line would tie into the heavily traveled Northeast Corridor at Philadelphia, allowing easy connections to Trenton, Newark, New York, Providence and Boston; Atlantic City; Wilmington, Baltimore and Washington.

- The corridor length of 300 miles is an ideal application for high-speed rail. In markets of 100 or fewer miles, the automobile's convenience will almost always predominate, as will the jetliner's speed in markets of 500 miles and more. In the intermediate range, high-speed rail can successfully compete on a cost and time basis. This has been proven elsewhere in the world with 125 to 170 mph service, and with Amtrak's service operating at as high as 125 mph in some parts of the Northeast Corridor. More to the point of the Philadelphia-Pittsburgh maket, this assumption has been verified in extensive ridership demand studies (the first performed in Pennsylvania in 20 years) that are summarized herein.

- A natural physical barrier, the Allegheny Mountains, separates Philadelphia and Pittsburgh. Under adverse weather conditions, those mountains render conventional travel by highway difficult. Moreover, the airports at Philadelphia and Pittsburgh are on the Federal Aviation Administration's list of heavy-traffic centers, and the number of landing slots for access is restricted at both facilities.

- The demand for transportation is increasing, while the options for meeting that demand are growing more and more difficult to implement. The Federal Highway Administration now estimates that Americans drive 1.6 trillion vehicle-miles a year, a figure that is expected to rise by 1 trillion by the year 2000. In Pennsylvania, increasing the lane capacity of the Turnpike all the way across the state, for example, would increase the volume capacity but would not significantly reduce actual driving time. The steady rise in demand for transportation facilities means that the growth of highway traffic will continue, but high-speed rail may slow its rate of growth. Building new airports at Philadelphia and Pittsburgh would be difficult, if not for reasons of cost alone, certainly from a land-use standpoint. New ground facilities would do little to ease air traffic congestion in the skies. Neither expanding major highways nor improving airports reduced travel time, and neither would offer the passenger any more protection from weather-related travel disruption than at present.

- In Pennsylvania as nationally, the ready availability and moderate price of gasoline encourages motorists to disregard the hardships, gas-pump lines and high prices brought on by disruptions in petroleum supply in 1974 and 1979. The chronic political volatility of the Mideast only makes it more likely that a disruption could recur. Should that happen, high-speed rail would help preserve mobility.

What This Report Does Not Cover

A suspension of funding curtailed work that was scheduled to have been performed in Phase 3, the final step in the study. Therefore, the PBGF consultants were unable to complete work on several critical issues. These are:

- A final assessment of economic impact.
- A definitive, detailed financing plan.
- An engineering plan.
- Further revisions of right-of-way alignment developed by the commission's general engineering consultants to effect cost reductions and improvements subsequently proposed by the oversight consultants and others.
- An independent engineering assessment of the proposed Transrapid International plan for implementing and ultimately helping to finance a magnetic levitation line between Harrisburg and Pittsburgh.

Prologue

As a transportation planner's option and as a public policy issue, high-speed rail is not an easy choice. It does not yet exist on American soil, and so suffers a psychological handcap manifested in the questions, spoken and unspoken, "Can it work here?" It carries with it uncertainties, political and financial risks, and a price tag in the billions of dollars.

Yet, high-speed rail's technical attributes and performance records -- financial, operational and safety -- speak for themselves. The technology not only works, but it is also an arena of continuing research.

Although surrounded by a host of issues and complexities, one principle is common to all the world's existing high-speed rail systems:

> **When clean, safe, comfortable, reliable, frequent, secure intercity trains are run on competitive schedules that save passengers time and trouble, the market responds. Wherever the concept has been implemented, it has succeeded. Specifically, it has succeeded technically and financially in markets for which a demand was proven (later Japanese Bullet train routes were built without primary regard for the marketplace; they were constructed to encourage regional settlement and development).**

By creating and funding the commission, the Legislature has acknowledged that present transportation solutions may be inadequate under future economic conditions and travel patterns. Other states apparently have come to similar conclusions; feasibility studies similar to Pennsylvania's study exist in Florida, Michigan, Nevada-California, Ohio, New York and Texas.

Sooner or later, Pennsylvanians will recognize that for managing transportation growth, the alternatives to high-speed rail come neither cheaply nor easily. Further, according to the commission's economic-impact analysis, they are unlikely to be as effective at stimulating the state's economy as high-speed rail.

Findings

The Commission finds that:

1. High-speed rail technology is available today.

2. A sufficient market exists in east-west travel to warrant further pursuit of high-speed rail.

3. High-speed rail will introduce beneficial short- and long-term economic effects to the Commonwealth.

4. The greatest such effect would be on a new and developmental business, the construction industry and rejuvenation of railroad-related industry.

5. The greatest benefits would come from the most innovative system, i.e., magnetic levitation, closely followed by a high-performance, high-tech, steel-wheel system such as the French TGV or West German ICE.

6. A modest upgrading of Amtrak service would offer significant travel-time improvements and may be least expensive, but it provides the least economic benefit among options studied.

7. The project requires a substantial initial investment and the amount of money invested at the beginning of the project will determine the extent and nature of the long-range economic impact. The size of the benefit to the state will be directly dependent on the size of the initial investment it makes. Conversely, should the state be required to entirely finance the project, considerable investment risk is involved.

8. Both West German and French suppliers have offered to help secure offshore financial assistance -- grants and/or loans -- to construct their high-speed rail systems in Pennsylvania.

9. With offshore help, the best-case scenarios (steel-wheel system at 180 mph or maglev at 250 mph) may be financially feasible now, based on the record of public and private financing of high-speed rail worldwide.

Editor's Note: The passage of federal legislation in late 1988 authorizes high speed rail tax free bonding authority.

TECHNOLOGY AND OPERATIONS

High-speed technology broadly falls into two groups: Systems that are practical and already operational in daily commercial revenue service; and those that have advanced far beyond the experimental stage but which have not yet moved from test track and laboratory to the marketplace. This study considered both options.

The choice of technology will determine the quality of service that can be offered. It will also determine the cost, the extent to which Commonwealth financial support will be required and the relative risk and payback. On the other hand, the choice of technology will determine the depth of impact on the state's economic development. Simply stated, the faster the service, the greater will be the time savings and the more passengers will come aboard. The more investment made in a system, the greater will be the short- and long-term impact on the state's economic development (see economic development section).

The High-Speed Rail Operating Concept vs. Existing Service

The high-speed rail operating concept envisions a complete package of service to the traveler. Stations would be equipped with ample facilities for parking, both to accommodate the private automobile and to provide for public transportation access. Depending on city, public transportation can comprise taxis, local and intercity buses, commuter trains, light-rail systems, subways, even inclined planes. Checked-baggage service and seat reservations would be offered.

Aboard the trains, light meal and beverage service would be available. Service would be of hourly frequency in each direction from approximately 6 a.m. to midnight. Depending on technology chosen, the cross-state trip time could take from about two hours to 3 hours 43 minutes.

A dedicated, passenger-train-only track is needed to enhance safety, speed and on-time reliability. This is the standard established by high-speed passenger operations around the world today. By restricting certain trackage to high-speed passenger trains, operators in France and Japan have:

- Eliminated dangerous highway grade crossings.
- Eliminated rail-traffic interference with slow, heavy freight trains and high-density commuter trains with their frequent starts and stops. This removes the heavy pounding of freight and accompanying costly track calibration. It enhances safety by removing the potential for collisions or derailments involving trains of widely varying weights and speed on either the same or adjacent tracks.
- Built an alignment that is straighter than otherwise possible, by constructing grades of 3-1/2 percent to 5 percent. (Grades must be kept to a minimum when trackage is shared with freight trains; the Conrail mainline across Pennsylvania achieves a maximum of 1.86 percent on the mountainous westbound climb between Altoona and Gallitzin.) Establishing steeper grades greatly reduces the need for costly excavation of tunnels.

Present-day rail passenger service across Pennsylvania is operated by Amtrak. Between Philadelphia and Harrisburg (104 miles), the right-of-way is owned by Amtrak and is electrified, and the trains are operated and dispatched by Amtrak. Maximum speed on this portion is 90 mph; average speed is above 50 mph. Between Harrisburg and Pittsburgh (248 miles), the trackage is owned and operated by Conrail, the Northeast's major freight carrier. Maximum speed is 70 mph; average speed is about 48 mph.

Frequency is five trains each way every weekday between Philadelphia and Harrisburg; one train a day each way between New York, Philadelphia and Harrisburg; one train a day each way between New York, Philadelphia, Harrisburg and Pittsburgh (the state-supported *Pennsylvanian*); and one overnight train a day each way between New York, Philadelphia, Harrisburg, Pittsburgh and Chicago (the *Broadway Limited*). Trip time is about two hours between Philadelphia and Harrisburg, and about seven hours between Philadelphia and Pittsburgh. Most of the Philadelphia-Harrisburg service traditionally has been provided with electric power, while the *Pennsylvanian* and *Broadway Limited* are diesel-powered. Amtrak recently began to experience a shortage of electric locomotives and

began to operate much, though not all, of its Philadelphia-Harrisburg service with diesel power. From time to time, Amtrak has considered abandoning electrification west of Downingtown, the present-day western limit of Southeastern Pennsylvania Transportation Authority (SEPTA) electrified commuter service. Under such a plan, all Harrisburg service would be operated with diesels and Amtrak has even considered single-tracking the line west of Parkesburg.

* * *

From a technical standpoint, high-speed trains are propelled and guided either by traditional, but high-tech, steel-wheel-on-steel-rail means, or by magnetic levitation.

Steel-Wheel-on-Steel-Rail Technology

There is no doubt that the French TGV (tres grande vitesse, or very great speed) trains are the world leaders in high speed steel-wheel technology. Introduced in 1981 and operated in full high-speed service since 1983, this fleet of 87 electrified trains operates routinely, day in and day out, at 168 mph between Paris and Lyons. It has proven to be a financially successful performer as well, returning 17 percent return on equity after bond debt repayments. Now French engineers and technicians are at work building a fleet of second-generation TGVs, which will run at 185 mph on a new high-speed route from Paris to the west country of France.

Similar in concept to the TGV is the West German ICE (Inter-City Express). The single electric-powered trainset has been tested at 252 mph and Deutsche Bundesbahn, the German Federal Railroad, has placed an order for fleet production (41 trainsets of two locomotives and 11 cars) to service new high-speed routes at 155 mph. These lines are being built as part of DB's overall transportation strategy to offer service that is twice as fast as the automobile (keeping in mind that there is no posted speed limit on the autobahn) and half as fast as the jetliner.

The Japanese Shinkansen, or Bullet Train, is widely known as the world's first true high-speed rail system, having gone into operation in 1964, at a commercial speed of 130 mph. Subsequent extensions and replacement of vehicles with second-generation rolling stock have increased the speeds to 150 mph on some lines. The financial performance of the electrified Bullet Train has been good on the original Tokyo-Osaka-Hakata route, but it has been less robust on the lines built solely for social reasons. Even so, the high-speed trains contribute about 32 percent of all rail passenger revenue in Japan. Taken as a whole the Bullet Trains achieve an operating ratio of about 56 percent, meaning that revenue exceeds expenses by 44 percent. Safety is the greatest superlative that the Bullet Train system can boast; the fleet has carried more than 2.5 billion passengers since it opened, without a single fatality or serious injury.

Under construction are three more high-speed electric train types that will approach or exceed the 150 mph commercial operation threshold. Italian State Railways is constructing the ETR 500 design for Rome-Florence service at 187 mph and the ETR 450 "active" tilting-body train for 155 mph services. The 140 mph British "Electra" locomotive design is being built for London-Glasgow and London-Edinburgh service.

Trains operating or planned to operate at the 125 mph level include the British HST, or Inter-City 125, a diesel-powered train that has tested at 148 mph; Spanish Talgo, a diesel- or electric-powered natural pendular "passive" tilting coach system; the Amtrak AEM-7 locomotive/Amfleet coach combination, operating at 125 mph in the New York-Washington Northeast Corridor; and the planned Swedish X2, a 125 mph "active" tilting-body train under construction.

The French-Built ANF Turbotrain operates in widely varying climatic conditions (France, Egypt, Iran and New York state) at speeds of as high as 110 mph. Outside of the Northeast Corridor main line, this is the fastest scheduled passenger service in the United States. Tests in France with gas-turbine-powered equipment have yielded speeds of as high as 191 mph. The Canadian LRC "active" tilting-body coach equipment operates on VIA Rail Canada behind diesel locomotives at 90 mph; it could be hauled by electric locomotives.

Banking Mechanisms

Several of these steel-wheel systems employ tilting-body coaches, in which the cars are mechanically banked as they round a curve. This reduces the discomforting effect of centrifugal force on passengers. By tilting the bodies of the coaches, approximately one-third higher speeds can be maintained through curves without the expense of realigning and straightening the track.

Engineers trying to perfect this technology have had difficulty achieving reliability; British Rail has abandoned efforts to do so with the electrically powered Advanced Passenger Train, or APT. After experimenting for several years, Canadian engineers say they have retrofitted LRC cars to correct reliability problems with the banking system in place on that rolling stock; however, this is a recent development and there is no proven record of performance over time. Only a few trainsets with banking engaged are assigned to a single route, and operational considerations sometimes preclude the banking system's being used. Technologies such as the LRC and the Italian and Swedish systems use a powered mechanism, triggered by sensors that detect when the train is entering a curve, to tilt the car bodies. This is called "active" banking.

By using a different method of suspension, the Spanish Talgo system relies solely on gravity to achieve its banking; thus it is called a "passive" tilting technology. This system has been in use in Spain and on international routes linking Madrid/Barcelona with Paris and Geneva for nearly 20 years.

In its investigation of candidate technologies to improve running times in New England, the Coalition of Northeast Governors (CONEG) High Speed Rail Task Force has paid special attention to both the LRC and the Spanish banking technologies as a means of achieving higher overall speeds without rebuilding the curving Shore Line route between New Haven, Conn., and Boston. This type of approach could find application in the Pennsylvania corridor although the need to provide dedicated passenger track would continue for reasons of safety.

Magnetic Levitation Technology

This technology uses no wheels or rails, but a concrete or steel guideway, above which the vehicle is magnetically suspended and centered, and propelled by a wave of magnetic energy. Because there is no wheel-to-rail contact, the "maglev" vehicle actually flies along the guideway without contacting it. Without wheel-rail contact, there is potential for greater speed than with wheeled vehicles -- in the range of 250 to 300 mph. Although no commercial maglevs are operating in revenue service at high speed, they are employed in public shuttle service at low speed. Test tracks in West Germany and Japan have yielded actual performances of speeds of more than 300 mph.

The Transrapid International consortium has built a 13-mile test track at Emsland, West Germany, on which it has operated its six-car TR-06 vehicle at 222 mph; 250 mph tests are planned now that a final link in the track layout has been completed. This system uses a T-shaped guideway around which a part of the vehicle wraps, eliminating the possibility of derailment. Electromagnets energized in the lower portion of the wraparound segment give the train its levitation by pulling up toward other electromagnets mounted on the underside of the guideway. The name associated with this principle of magnetic physics, using forces of opposite polarity, is electromagnetic, or attractive, maglev. Additional magnets provide lateral guidance, or centering. A long-stator electric motor, with windings mounted in the center of the guideway, reacts with electromagnetics mounted beneath the main body of the vehicle. The rapid changing of polarities induces a pushing and pulling force, creating propulsion.

During the commission's technology inspection trip, several members rode the TR-06 -- the first foreign group to do so, according to Transrapid -- on its Emsland test track and found it to be smooth, quiet and comfortable at 125 mph; no faster speeds were attempted while the group was aboard, although it subsequently ran at 257 mph with passengers aboard. Japanese Railways has tested the MLU-001 magnetic vehicle at 250 mph on a 4.2-mile track at Miyazaki, Japan. (An unmanned vehicle achieved 321 mph in 1979). This system uses a U-shaped guideway in which the vehicle rides the center of the U. The vehicle is lifted from the bottom of the guideway and repelled from its sides by the use of electromagnets in an electrodynamic, or repulsive, mode. Forward motion is generated in the same manner as with the attractive system.

Japan Air Lines and Sumitomo Electric have developed an HSST-03 maglev vehicle that has been operated with high reliability in 19-mph shuttle service. The vehicle's technology is of an attractive-physics design like that of the West German TR-06. Its promoters claim it can operate at 180 mph, but is has not been tested in that range.

During its technology tour, the commission delegation also inspected and rode a maglev people-mover at Birmingham, England, which connects an airport, train station and convention center. While it demonstrated a successful application of the technology, it was limited to

speeds of no more than 30 mph. It cannot be considered a candidate for intercity travel.

Applicability to Pennsylvania

Most of the technologies listed are suitable for use in the Philadelphia-Harrisburg-Pittsburgh corridor. All maglev systems would require construction of new guideway for the entire length of the route. Here is a comparative breakdown of the advantages and disadvantages of maglev and steel-wheel systems:

Benefits of Maglev

- Greater economic impact (more jobs during construction; heavier passenger usage upon completion) than steel-wheel system.
- Establishment of state-of-the-art transportation in Pennsylvania and the United States.
- Establishment of entirely new technology center as a new industry in Pennsylvania.
- Would allow export of specialized maglev technology to other states, creating more jobs and economic growth.
- Higher train speeds (250-300 mph rather than 150-180 mph).
- Potentially lower operating and maintenance cost than steel-wheel-on-steel-rail designs.
- Environmentally superior to highways as a means of handling transportation growth in Pennsylvania.
- The innovative concept could attract new technology financing.

Disadvantages of Maglev

- No revenue service system experience.
- Neighboring states and Northeast Corridor not considering maglev as an alternative; thus, through service is precluded on trips such as Pittsburgh-New York or Harrisburg-Atlantic City, NJ.
- Risks associated with new technology may pose financing problems in the traditional marketpl
- Operation under some adverse weather conditions net yet tested.

Benefits of Steel-Wheel

- Broad-based proven service experience of steel-wheel on steel-rail mode reduces implementation risk and financing risk.
- Would allow export of high-speed technology to other states, creating more jobs and heightening economic impact in Pennsylvania.
- Supports state's existing railroad manufacturing and supply industry.
- Compatible with existing Northeast rail system; allows through service to New York, Washington, Atlantic City.
- Compatible with high-speed rail plans of Ohio, New York, other contiguous states.
- Makes maximum use of existing rail rights-of-way in Pennsylvania.
- Environmentally superior to highways as a means of handling transportation growth in Pennsylvania.
- Potential to achieve full electrification, full separation of freight and passenger services, full elimination of grade crossings.

Disadvantages of Steel-Wheel

- Some of investment may be lost if system is upgraded to maglev.
- Overall economic impact likely not as great as with maglev.
- Unlikely to match maglev in speed.
- Prospects less certain for establishing state-of-the-art American high-speed rail industry in Pennsylvania.

OPTIONS FOR PENNSYLVANIA

From technical, financial and operating standpoints, three types of systems were studied as candidates for implementation in Pennsylvania. Based on the consultants' work in Phase 1 and Phase 2 of the feasibility study, the commission voted to pursue the most technologically advanced systems -- a 250 mph maglev system and a 180 mph high-performance steel-wheel system similar to the French TGV or West German ICE. Descriptions of the proposals follow, along with notations as to their strengths and weaknesses, and modifications and changes of approach suggested by various parties.

Option 1: Maglev Service

The consultant's initial investigation into maglev service produced a cost estimate of $10 billion for a double-guideway system across the state. At the top speed of 250 mph, this system would have allowed cross-state trip times of about two hours. It also would attract the most passengers and created the greatest economic impact. The high initial cost estimate and the probable difficulties of financing cast a shadow on this approach. Transrapid International claimed that the engineers' estimates were far too conservative (high), and that realistic costs based upon actual construction experience should be far lower. Methods of economizing on the initial capital cost estimates were unable to be pursued by the commission's consultants because of the funding cutoff.

In light of this development, Transrapid International proposed an incremental, staged plan for Pennsylvania, based on starting with limited maglev service and expanding its scope after gaining operating experience and achieving a financial performance level. The commission's consultants were unable to provide an independent assessment of this proposal.

The Transrapid proposal begins by implementing a 250 mph maglev system between Harrisburg and Pittsburgh with stops at Lewistown, State College, Altoona, Johnstown and Greensburg. Initially, dedicated passenger tracks and other facilities would be constructed to allow steel-wheel service between Philadelphia and Harrisburg at standards somewhat mirroring or exceeding those of an early commission study plan, Phase 1 Alternative C. Transrapid has stated that the maglev portion of this system will cost no more than $3 billion. This cost is based on a single guideway track diagram with two 25-mile passing sidings, and no tunnels. Transrapid officials repeatedly have stated that the cost can be held to $3 billion maximum and they further have stated that they would assist in procuring offshore public and/or private financing to build such a system in Pennsylvania. Running time for the Harrisburg-Pittsburgh maglev section would be 1 hour 29 minutes, making five stops.

The commission's consultants studied each of the technologies and reported on them in "pure" form. That is, they estimated costs, revenues, performance standards and ridership based on full use of each technology from Philadelphia to Pittsburgh. However, few transportation improvements in history have been built all at once, and both the commission's engineering consultants and engineers representing maglev and high-speed steel-wheel systems have urged consideration of a staged approach. The general engineering consultant, in fact, produced a series of tables showing the greatest time reductions for the least dollar investment per route segment.

In the case of maglev, this could be implemented as follows: While construction begins on the Harrisburg-Pittsburgh guideway, steel-wheel trains of diesel, turbine or dual-power-electric design could provide moderately improved service in the interim. This could be accomplished by taking over through lease, purchase or transfer the Amtrak line between Philadelphia and Harrisburg, and constructing the dedicated passenger tracks and other facilities required to allow faster speeds. These high-performance trains could then operate at conventional speeds (based on safety considerations grounded in dispatching, track geometry, braking distance, signal limitations, and compatibility with freight operations) over Conrail trackage from Harrisburg to Pittsburgh. When the Harrisburg-Pittsburgh maglev section is completed, steel-wheel trains would continue to operate on the dedicated trackage between Philadelphia and Harrisburg at speeds of 130 to 150 mph, lowering the running time between those two cities from its current two-hour level to between 52 minutes and 69

minutes. Thus, a cross-state trip, allowing five minutes for passengers to transfer at Harrisburg, would take between 2 hours 26 minutes and 2 hours 43 minutes. Ultimately, after the maglev system establishes an operational and financial performance record, the Philadephia-Harrisburg section would be converted to maglev, bringing total trip time to less than two hours.

This approach has the advantage of offering a substantial improvement to existing service, while emboding a state-of-the-art component as well. Its disadvantage is that it requires passengers to make a cross-platform transfer between maglev and steel-wheel trains at Harrisburg for an interim period.

Cost of the incremental system would begin with the Transrapid estimate of $3 billion, plus the cost of providing dedicated passenger tracks and other facilities required for upgraded steel-wheel service between Philadelphia and Harrisburg, which must be investigated.

Option 2: High-Speed High-Tech Steel-Wheel Service

This services proposal would resemble the French TGV operation, with trains running at 180 mph and taking about 2 hours 41 minutes to make the cross-state run. The commission consultant's initial estimate for implementation of electrified 170 mph TGV- or ICE-type steel-wheel service produced a capital cost estimate of $7 billion. This figure has been challenged as being too high by TGV engineering specialists and by the commission's own oversight consultants. Consultants have observed that while construction of right-of-way between Harrisburg and Pittsburgh gets under way, service could begin with equipment operating at conventional speeds on the existing Philadelphia-Harrisburg line, which ultimately would be upgraded to allow higher speeds, or replaced with new alignment.

Initial Phase 1 steel-wheel cost estimates have been called unrealistic in that they were based on alignment assumptions that used moderate grade-climbing ability and involved extensive tunneling, the excavation cost of which alone ran into the hundreds of millions of dollars. SNCF -- the French National Railways -- and others are operating their trains in Europe over much steeper grades, and they believe that an alignment can be drawn that will involve no tunneling. The Phase 1 estimates also have been criticized as conservative (too high) by suppliers, who, on one hand, hold a vested interest in seeing a more palatable cost estimate, and on the other, have a first-hand acquaintance with actual costs of construction overseas, and thus are in a position to provide the most accurate, experience-based figures available for existing systems. The capital cost estimates also have been called extremely conservative -- perhaps 25 or 30 percent higher than they need be -- by the commission's oversight consultants, STV Engineers with R.L. Banks and Associates, who suggest that the capital cost ought to be closer to $5 billion. The TGV Company has offered to provide estimated train-performance running times, and additionally offered assistance on issues of cost and revenue determination, and sources of financing.

The TGV Company, American marketing arm of the French rolling-stock manufacturers, has stated that it is prepared to make a proposal for such service, and that it stands ready to assist in procuring financing much in the same manner as the West German consortium. TGV Company cites several studies that claim comparable construction costs for high-speed steel-wheel systems that are 20 percent to 30 percent less expensive than maglev, and operating costs of 15 percent less than those of maglev.

The cost ranges from an <u>estimated</u> $4-5 billion to the conservative initial estimate of $7 billion; the actual figure cannot be determined until optimized alignment (determing highest performance at lowest cost) is drawn. TGV Company remains prepared to provide assistance described above in determining actual cost estimates.

Option 3: Moderate-Speed Steel-Wheel Service

The commission's engineering consultant, Parsons Brinckerhoff/Gannett Fleming, has determined that a modest high-speed steel-wheel-on-steel-rail electrified system could be built for $2.55 billion. The commission has consistently taken an approach that favors the faster technologies, but more cost-effective alternatives have never been entirely ruled out. Operating at 125 mph with 150 mph running on some stretches, this system could cut the seven-hour Philadelphia-Pittsburgh travel time to 3 hours 43 minutes.

A low-cost alignment design would provide passenger-dedicated track in the existing Amtrak-Conrail corridor with only 50 miles of realignment into new right-of-way. This plan

would create a 340-mile route that would enjoy the advantage of a lower capital cost and a much shorter design and construction period. Cash inflow, as a result, would begin in a much shorter time. Rolling stock could be either of the TGV-ICE type, or of the LRC, Turbo, Talgo or even Amfleet design. The alignment would retain speed-limiting curves until they are straightened or eliminated through future improvement programs; also, safety concerns over site location near Conrail freight trackage would have to be addressed. While not as dramatic as the first two operations, this concept would offer substantial improvement in trip time and frequency over the current service, roughly halving the current Philadelphia-Pittsburgh rail travel time of seven hours.

The commission did not have the opportunity to have its engineering consultants thoroughly examine this proposal. The option poses safety concerns, especially west of Harrisburg along the Conrail route, with so much of its track location adjacent to existing freight tracks. Recent derailments in Maryland of CSX Corp. freight trains on trackage immediately adjacent to the Washington Metro system have brought this issue into sharper focus. An apparent advantage of this system is that, for a relatively modest cost, it would demonstrate dramatic near-term improvements, while allowing for long-term upgrading -- not unlike the Turnpike -- to higher performance standards by future straightening of alignment. A major disadvantage is that the option greatly dilutes the economic-development potential of the faster systems. Because it utilizes existing technology already being produced elsewhere, the prospects for launching a new American high-speed rail industry in Pennsylvania and obtaining resultant economic development benefits are missing.

Another advantage, although it is a long-term one, is that the operating margin would exceed the debt service requirement in the year 2006, the estimated 13th year of operation. Cumulative positive cash flow after debt service would be $14 billion by the year 2027, when the bonds will be retired.

The cost of this alternative has been estimated at $2.55 billion.

ECONOMIC DEVELOPMENT

At least as significant as the transportation impact of high-speed rail is its economic development potential. High-speed rail would be a catalyst for economic growth -- growth that would help the state overcome years of declining investments, jobs, and population; and growth that would help reduce unemployment to a more desirable level, and provide substantial tax income for the Commonwealth.

Construction Benefits

At least two-thirds of the expenditures for construction can be gained by Pennsylvania firms. Among major construction contracts awarded in the state over the last several years, state-based firms or those with significant operations in Pennsylvania have won 80 percent. Railroad officials have verified that state firms compete successfully for trackwork, electrification and signal work. And as a result of the experience of assembly of foreign rolling stock in Pittsburgh and discussions with vendors such as the Budd Company, it is clear that a portion of the expenditures for rolling stock, parts and assembly, could be captured by firms with plants in the state. Direct expenditures would stimulate further economic activity through the multiplier effect. Income received by the construction and manufacturing firms would be spent to acquire supplies and equipment from other Pennsylvania firms, and to pay labor. Income received by these firms and individuals would in turn be used to purchase goods and services.

As a result, a dollar of direct expenditure will generate several dollars of total expenditures. For a $2.55 billion steel-wheel system (Option 3), the result is a $6 billion increase in total expenditures during the six-year construction period. For the high-speed steel-wheel system, Option 2, the $7 billion capital expenditure brings an estimated $16 billion in total construction expenditures. And the maglev system, Option 1, produces $22 billion in construction-period benefits in return for the $10 billion capital cost estimate.

New expenditures mean new construction jobs -- as many as 25,000 annually for maglev, or Option 1; 22,000 annually for Option 2; and 13,000 annually for Option 3.

Jobs in turn mean growth in personal income -- an increase of at least $1.39 billion during construction or $5.34 billion total over the operating life, for the most modest system. The higher technologies yield even more -- $8 billion in personal income for the high-speed steel-wheel system (Option 2), and $9.4 billion for maglev, or Option 1. State government revenues would increase by $492 million (for Option 3) to $755 million (for Option 2) to $882 million (for Option 1) over the construction and 30-year operating life of the system. These revenues would be derived through increased income, sales and other tax receipts.

Importantly, the primary beneficiaries of the construction would be those Pennsylvania industries that have suffered difficult times over the past decade and more. Overall, manufacturing firms and construction firms would capture about 60 percent of the economic activity generated by system construction.

Pennsylvania is well positioned to reap the benefits of high-speed rail. Because of the major role the railroading industry has played in the state's economy, Pennsylvania already has numerous railroad-supply firms that manufacture everything from track spikes to locomotives. Two of the nation's three steel rail mills, for example, are situated in Pennsylvania. Other companies make rolling stock, steel wheels and axles, signal and computerized control systems, air brakes and braking components, rail joint and other track fittings, and concrete crossties. Roadbuilding contractors, already numerous because of Pennsylvania's heavy investment in highways, could benefit from contracts for right-of-way grading and bridge and tunnel construction. Railroad engineering and construction management firms also are based here. Clearly, no other state considering HSR has as mature and experienced a supply industry in place and ready to benefit from HSR construction.

To put the economic benefits in the context of the Pennsylvania economy, consider what the added employment would mean to the anticipated growth rate in jobs without high-speed rail. Employment in the state is currently forecast to grow by about 36,000 jobs annually. As noted, high-speed rail could provide a minimum annual

average of 13,000 jobs during construction for the most modest system. Thus, the growth rate would be increased by at least 36 percent over this period of time. For Option 2, the rate would be 62 percent, and Option 1, maglev, the growth rate would be 70 percent. After system operations begin, the boost to the growth rate would be less substantial. But the significant difference here is that the economic benefit of HSR operations would be permanent -- they would occur year after year.

Operations Benefits

It would cost $98 million annually to operate and maintain the system under the least advanced approach, Option 3. The cost for the higher technologies is estimated at $105 million for Option 2 and at $104 million for Option 1, maglev. Some 85 percent of these expenditures would benefit Pennsylvania firms and labor. The result, accounting for the multiplier effect, would be some $460 million annually, under the best case, in new expenditures after operations begin.

These expenditures translate into:

- A total, in direct and indirect employment, of 7,600 to 12,500 jobs.
- Annual personal income of $160 million to $205 million.
- State tax revenues of $15 million to $19 million annually.

Distribution of Benefits

The estimated distribution during construction is a function of each area's ability to capture direct expenditures and associated multiplier effects. The major industrial and service centers in Philadelphia, Pittsburgh and other places like Erie, Allentown and Bethlehem, are anticipated to collect the lion's share of benefits during construction. After operations begin, jobs would be more heavily concentrated in those areas served by high-speed service, because direct employment and travel-related expenditures would occur primarily in those areas. Electric utilities across the state would gain by selling commercially produced power to the system for train propulsion and general use.

Downtown Development

HSR can revitalized downtown areas by stimulating the development of real estate near stations. Construction of retail, hotel, restaurant and office buildings will accompany the introduction of modern, efficient transportation in the downtowns of cities served. This phenomenon already can be observed in Lyons, France, adjacent to the high-speed TGV station there; and in such places as Toronto and Washington, and Philadelphia's Market East station with the metrorail and commuter rail systems in each city. Harnessing the rising value of real estate surrounding each station is one way to help amortize the capital cost of constructing high-speed rail.

Structural Benefits

High-speed rail can enhance the ability of a state or region to compete with others for new investment and economic activity. The creation of a high-speed rail industry in America is an example of how this might occur. Clearly, with advanced feasibility studies under way in so many states, faster trains are coming to this country. Pennsylvania is not alone; others under study are Florida (Miami-Orlando-Tampa), Ohio (Cleveland-Columbus-Cincinnati), Texas (Dallas-Houston), Nevada/California (Las Vegas-Los Angeles) and Michigan, Indiana and Illinois (Chicago-Detroit).

Regardless of where the first system is built, high-speed rail will be a multi-billion-dollar industry and the states that are the first to create such a system will be in the best position to export their goods and services and their expertise to others.

Travel and Tourism

In France, it is estimated that 20 percent of the travel on the TGV is induced travel, or travel that would not occur were it not for high-speed rail. This kind of transportation could open up the recreational areas of Central Pennsylvania, provide wider access to Pittsburgh's sporting events, and facilitate travel to the historic sites of Philadelphia. Further, it would facilitate trade, communication and cultural links between Philadelphia, with its Northeast Corridor orientation and financial centers, and Pittsburgh, with its more Midwestern leanings and its status as one of the largest corporate-headquarters centers in America.

Pennsylvania's Image

Another area is the promotion of Pennsylvania's image as a desirable place in which to do business. This is the toughest economic benefit to

measure, but it is generally recognized that attitude has a great deal to do with industrial development decisions.

An investment in high-speed rail that is soundly financed and well operated can demonstrate that a state can do something progressive, positive, imaginative and on a large scale to support its economy. This would make a great difference to businesses trying to decide whether or not to locate in Pennsylvania.

Accessibility

Yet another consideration is accessibility. Many of the structural effects derive from improved accessibility. Historically, transportation is at the core of economic development, as can been seen in our highway system, ports and airports, along rapid transit lines and along rail freight corridors. HSR also has the potential to be this kind of economic development catalyst.

Other Benefits

Other benefits associated with high-speed service:

- Lower unemployment and reduced associated costs of public support of jobless workers.

- Opportunities for young skilled workers to remain in Pennsylvania rather than having to move elsewhere to find employment.

- More productive use of time. HSR avoids much of the wasted time associated with traveling to outlying airports, canceled or delayed flights caused by weather or equipment problems. Most seasoned travelers have learned to allow extra time to account for such delays.

- Improved safety, compared to highway, air and conventional rail travel. The Japanese Bullet Train fleet has operated for 23 years and carried more than 2 billion passengers, all <u>without a single fatality</u>. Well-planned and precisely operated systems running over "dedicated" (to one kind of traffic HSR) rights-of-way offer the safest transportation known to man. The French TGV system, in full operation since 1983, has demonstrated a similar perfect record of safety.

MARKET DEMAND (RIDERSHIP)

Market demand analysis has been summarized in a report, released in July 1986, that concentrated on this issue. Taking more than a year to conduct and costing about $425,000, this analysis took a snapshot of existing travel patterns and assigned dozens of mathematical values to them according to economic, attitudinal and infrastructural factors at point of origin and point of destination. Using established formulas for ridership projection that have been proven in other applications, the process then projected, with as much certainty as can be attached to future predicting activities, a scientifically qualified estimate of ridership. It was based on how present-day travelers in the Philadelphia-Pittsburgh corridor might conservatively respond to a new mode of transportation in the year 2000, with economic conditions that likely would prevail then.

On a comparative scale, the Pennsylvania projections appear to be well within the range of probability when compared to estimates prepared for corridors in other states. The forecast completed by Parsons Brinckerhoff/Gannett Fleming estimated 5.5 million travelers (for 180 mph steel-wheel service under the least optimistic conditions; essentially, Option 2) to 8.8 million travelers (for 250 mph maglev service -- Option 1 -- under the most optimistic conditions) annually by the year 2000. This represents 15,000 to 24,000 daily travelers. A study performed by Barton-Aschman Associates for Florida's high-speed proposal estimated 20,000 daily riders by the year 2000 on the proposed Miami-Orlando-Tampa line. The same firm conducted a ridership study for the proposed Las Vegas-Los Angeles high-speed line, and concluded that a market exists for about 4 million passengers (about 11,000 riders a day) in the year 1995, rising to 5 million by the year 2000 (13,700 daily). A survey performed in Ohio by Transmark showed a market for 7 million passengers a year, or 19,000 riders a day by the year 2000, in the Cleveland-Columbus-Cincinnati corridor.

By contrast, it should be noted here, one of the principal reasons for the lack of public confidence in the failed American High Speed Rail Corp. proposal for Los Angeles-San Diego service was its estimate of 100,000 daily passengers, which most transportation planners found difficult to accept. It was, in fact, the stimulus for the High Speed Rail Association to develop a set of Standard Guidelines for Revenue and Ridership Forecasting, through HSRA's Demand Forecasting Committee. The Pennsylvania ridership study was the first market demand study conducted according to those guidelines, which call for realism and conservatism in projections. Other studies now in progress in Florida, Ohio and Texas are incorporating these principles and following these guidelines.

The forecast is based on current east-west travel patterns in the state, documented through a questionnaire survey that brought nearly 8,900 responses, and on expressed preferences and choice-of-travel-means (mode-choice) tendencies documented through focus-group sessions conducted by Gannett Fleming and by Opinion Research Corp. of Princeton, NJ. From these data, projections were made for low, most-probable and high scenarios and for both a high-speed steel-wheel system and a maglev system. At the time the ridership study was conducted, the commission had opted to study only the faster technologies; as a result, detailed analysis of ridership for the modest steel-wheel system, Option 3, was not then included. The ridership estimates for that system were performed later and in less detail; they would require further verification. Steel-wheel vehicles with a 180 mph top speed could cover the 307-mile route in about 2-1/2 hours, and 250 mph maglev trains could cover the same distance in 1 hour 54 minutes.

For the 180 mph steel-wheel proposal, the study found that by the year 2000, a system could attract 5.46 million riders in the low (that is, least optimistic) case, 6.569 million riders in the most-probable case and 7.781 million riders in the high, or most-optimistic, case. By the year 2010, when the system presumably would have gained user acceptance, those estimates rise to 6.72 million riders, 10.53 million riders and 14.3 million riders.

In the case of a faster maglev system, the study forecasts 6.254 million riders in the low scenario, 7.495 million riders in the most-probable case and 8.813 riders in the high case. Those estimates rise, by the year 2010, to 7.7 million riders in the

low case, 11.3 million riders in the most-probable case and 16.2 million riders in the high case.

To place these figures in some perspective, the range of estimates for the 180 mph steel-wheel option -- 5.46 million to 7.78 million annual riders by the year 2000 -- is approximately half the current Paris-Lyons TGV ridership. It also can be compared with today's Amtrak ridership in the Pennsylvania corridor, which, until recent frequency discontinuances, was about 1 million riders a year, most of them east of Harrisburg. The current trip time between Philadelphia and Pittsburgh is seven hours over the former Pennsylvania Railroad (now Amtrak and Conrail) main line. Frequency is eight trains each way weekdays (fewer on weekends) east of Harrisburg, and two trains daily wast of Harrisburg. For purposes of ridership estimation, high-speed service was assumed to be hourly from 6 a.m. to 11:30 p.m.

One of the key findings of the study was the great majority of travel in Pennsylvania now takes place at an elapsed time of two hours or less. The significance of this is that if high-speed rail can bring the eastern and western reaches of the state to within this span. A two hour trip is even more acceptable if it can take the traveler across the entire state.

Another finding was that frequent business travelers, including some commuters, would constitute the largest subgroup of travelers on high-speed rail, for about 9,500 to 10,500 trips per weekday, or 57 percent of a total weekday ridership of 16,600 to 18,700 passengers. For purposes of this study, frequent business travelers are defined as those who ride three or more times a week, either on business or from home to work. Occasional business travelers, defined as those who make a business-related trip once or twice a week, would add another 4,600 to 5,500 passengers each weekday, for 28 percent. Tourists would account for 1,500 to 1,600 riders a weekday, or 9 percent. School trips represent about 500 trips a day, or 3 percent.

Fares were assumed to be in the range of 16 cents a mile to 28 cents a mile, with the average fare being 22 cents a mile. Higher fares would be charged for business travel that is less price-sensitive than other market segments, lower fares for off-peak and incentive travel.

The ridership estimation process began with a review of mathematical equations commonly used for travel demand forecasting. Two were selected, the "trip generation-distribution" method and the "multi-nominal choice mode" method, to cross-check each other. Written in computer language, the equations are known as a model, or computer model.

The second step was to conduct an objective travel-habits survey in the Philadelphia-Harrisburg-Pittsburgh corridor. This was done in May and June of 1985, with 25,538 questionnaires being handed out aboard Amtrak trains, to Turnpike motorists and to airline passengers. A total of 8,853 forms were returned, either in person or by postpaid mail, for a 34.6 percent response rate, which is considered high by almost any survey standard.

In all, 3,639 forms were handed out to Amtrak passengers, with distribution taking place aboard every scheduled Amtrak train on the timetable. including both weekdays and weekends; 2,510 were returned for a 69 percent return rate. A total of 19,925 forms were distributed from 22 Turnpike tool booths (the highest-volume interchanges) and 5,173 forms were returned, for a rate of 26 percent. A total of 1,982 forms were handed out to airline passengers waiting to board flights in Philadelphia, Harrisburg and Pittsburgh, and 1,170 of them were returned, for a response rate of 59 percent.

The survey was conducted in May and June to capture a representative sample of travelers; some school-related travel occurs then that would not occur in midsummer, and travel patterns were not yet advanced into summer to be skewed by a high percentage of vacationers.

Questionnaires were intended to find out who is traveling in the corridor, how often, why and by what means; what time of day they travel; and how long it took to make the total trip; origin and destination; and who is paying for the travel. Because the actual number of trips made on each mode for the days of the survey was known, the results were mathematically factored to represent total daily corridor travel.

In August 1985, PBGF and Opinion Research Corp. conducted a series of subjective market research surveys in Philadelphia, Harrisburg and Pittsburgh. This involved recruiting 215 randomly chosen but qualified volunteers, people who had traveled at least 50 miles within the corridor during the preceding year. These people were tested in a focus-group setting to determine the

criteria by which they select how they travel, specifically to learn how much weight they place on such important but difficult-to-quantify aspects as comfort, convenience, amenities, reliability, security and perceived safety.

The most important attributes on which travelers base their choice-of-mode decision were schedule reliability, cost, frequency and average speed or travel time. The most important characteristics for the frequent business traveler were cost, reliability and frequency, with cost being the single greatest factor. Weather vulnerability also played an important role. Those who travel for other trip purposes (tourist, school, "other") judged trip time, cost, reliability and frequency to be the most important factors.

After the rail-turnpike-air survey and the market surveys were conducted, the process of demand estimating was begun. For each trip from the field survey, detailed tripmaking criteria were entered into the computer program. Each was tabulated by origin and destination, with socioeconomic data also entered for each of 121 origin and destination zones. Among the socioeconomic factors were population, area, average per capita income, number of families, average family income, employment density, size of labor force, number of hotel/motel rooms and college enrollment. High-speed rail, station-to-station trip times and overall running times were calculated, using a train-performance computer model, to help evaluate how high-speed rail would compare to other modes in the demand analysis.

The computer models then were calibrated, or checked for accuracy against "known" or "observed" conditions, and the formula was adjusted. This step was necessary so that when socioeconomic and mode-choice data for the future are substituted for contemporary data, the resulting output will be as realistic and documentable as possible. Further sensitivity tests were conducted to determine the effect on the estimating process of such variables as travel time, cost, service frequency, and time spent getting to and from the chosen mode. The latter point, access and egress time, is a vital one; the study notes that "of special importance is the inclusion of adequate parking in the station designs," to make it as easy as possible for patrons to use the overall system, as contemporary airport planners have done.

Finally, the computer model was loaded with expected year 2000 socioeconomic data for each of the 121 origin-destination zones. Total estimated travel demand and traveler preferences were also added to determine the year 2000 modal split, or tendency of the traveling public to select each of the modes. It was from this analysis that the final estimates were drawn. Among the issues addressed are a range of the uncertainties in forecasting, the effect of high-speed rail on other modes, and the effect of high-speed rail on the number of trips for various trip purposes. Additional considerations were the effect of competitive strategies by other carriers against high-speed rail and the effect of real estate development around the station sites.

Not surprisingly, Pittsburgh (at 8,600 to 10,400 passengers) and Philadelphia (at 10,400 to 22,400 passengers) registered the largest estimated volumes of weekday traffic, both boardings and detrainings. In descending order are Great Valley/Paoli, Harrisburg, Lancaster, Greensburg, Altoona, State College and Johnstown.

Besides the base demand estimates, the consultants considered possible ridership markets that do not now play a role in current travel patterns, and these were figured into the final forecasts. First, a factor was added to account for the possible ridership that would occur because of a direct rail link at Philadelphia to an Atlantic City train service, scheduled for implementation by Amtrak and the State of New Jersey. For the steel-wheel 180 mph system, it was estimated that this would add 84,000 passengers a year in the low and most-probable cases and 120,000 riders a year under the optimistic cases. For maglev, it would add 86,000 passengers a year under the low and most-probable cases, and 123,000 passengers a year under the optimistic case.

Second, the effect of a hypothetical midstate resort/hotel/them park development was considered. In the low scenarios for both steel-wheel and maglev systems, no additional ridership was assumed. For a steel-wheel system, 237,000 passengers a year were estimated for the most-probable case and 788,000 passengers for the optimistic case. For maglev, the figures were 241,000 for the most-probable case and 805,000 for the high or optimistic case.

* * *

The oversight consultants, STV Engineers with R.L. Banks and Associates, endorsed the work of PBGF in demand estimating. Saying the work

"represents the most comprehensive ridership estimate this firm has reviewed to date, whether urban or intercity travel was in focus." STV also complimented PBGF on a number of other points, including tests of reasonableness and conservative estimates of the number of induced (new) trips projected. The range estimated, STV wrote in its report, "is but a fraction of the San Diego-Los Angeles prediction, which caused considerable uncertainly at the financing stage of the project."

STV also found that PBGF's inclusion of consideration of possible competitive strategies by competing carriers to be an "attractive feature," noting that "ridership estimates usually are seen to be made in a theoretical static environment, while in fact, the people transportation market is volatile and dynamic."

FINANCING

Editor's Note: Preliminary financing studies were initiated by the consultants. Before a detailed study could be accomplished, funding was discontinued. In the meantime, there have been new technology developments and new Federal legislation, which provides for tax free bonding for High Speed Rail projects. These developments have completely altered the bottom line. Consequently, no valid financial package exists for the options considered in the study. A financial plan should be developed.

The information which follows is based on preliminary financing studies conducted by the consultants in 1987 and earlier, and should be considered only in that context.

* * *

A synopsis of the financing work performed for the commission follows; it is derived from fact sheets provided to the commission by the general engineering consultant and computer spreadsheets provided by the financial subconsultant in March 1987. As noted in the introduction to this report and in the recommendations, it does not address some avenues of capital funding that are now being considered in other states.

The preliminary financing analysis performed for the commission draws the conclusion that the only affordable high-speed rail system is that which uses the least advanced technology and costs about $2.55 billion. This automatically ruled out any consideration of maglev (Option 1) or the high-speed steel-wheel technology (Option 2), without further study as to how cost estimates could be reduced or how construction could be advanced in stages. Conservative in nature, this approach was based on a premise that no federal assistance, of any kind, is available and that no foreign financing can be found. Further, it did not take into account methods by which the presumed lid on capital costs might be overcome. These means include considering the cash contribution available from real estate value-capture programs, which would turn revenue derived from the retail, hotel and office development in the vicinity of stations back to the high-speed rail system.

Excluding these potential revenue-producers resulted in an assumption that the only source for capital funding is the Commonwealth itself, on a full faith-and-credit basis. However, representatives of foreign suppliers have offered to help locate sources of foreign financing to build high-speed rail in the United States and specifically, Pennsylvania. And, by requesting that the general engineering consultant produce a station development report, the commission clearly indicated its intent to harness real estate values to make the system more financially self-sustaining. The federal political climate and deficit-reduction sentiment at the national level suggest that direct federal grants to build such a project are not in the offing. However, federal assistance in a form other than direct capital outlay could substantially aid the project, specifically in the form of tax-free status for revenue bonds. This status was specifically conferred upon the Ohio high-speed rail proposal via a special exception in the 1986 federal tax reform act. Extending that status to other projects, based upon their public benefit, would, in fact, make some projects feasible that otherwise would not be.

Thus, the results of the commission's financing analysis are accurate in preliminary fashion, within the narrow context in which they were conducted, but incomplete. It is these additional areas of financing details that were to have been addressed during the final phase of the commission's work, and which should be studied in any further consideration toward implementation of high-speed rail. A re-evaluation of the financial assessment would be necessary in any event in view of the significant tax-law changes that have ensued. Further, Phase 1 capital costs were extremely conservative; lower costs resulting from optimized alignment work were not developed, and reviewing this issue also will be necessary for any subsequent reexamination of the proposal. No discussion of financing high-speed rail in Pennsylvania can be complete without reference to the West German consortium of Transrapid International. Transrapid proposed in the spring of 1987 to design and build a

maglev system between Harrisburg and Pittsburgh at a cost not exceeding $3 billion, and pledged its assistance in locating offshore capital financing. This engineering proposal is contained in an addendum. A representative of the TGV Co., suppliers of the French steel-wheel high-speed train, subsequently made a similar offer.

The financial consultants assumed that the only source of funding for capital expenditures would be the Commonwealth and concluded that both the early $7 billion high-speed (180 mph) steel-wheel plan and the early $10 billion maglev plan contained considerable investment risk and were not financeable. Using the same premise, the consultants said a lower-performance (125 mph, with a few stretches of 150 mph operation) system costing $2.55 billion could be financed. In that scenario, the state would be required to invest $100 million a year in the first nine years and $150 million a year for an additional seven years, for a total investment outlay of $1.95 billion. At the end of the 40-year bond cycle, however, the system's revenue operations would have repaid that investment several times over, returning to the state a positive cash flow of $14 billion. Operationally modest by comparison to the performance of the 180 mph and 250 mph trains, this system could form the foundation for an incrementally improved service.

The commission believes that the financing analysis is accurate but overlooks significant instruments by which a plan could be implemented, thus missing the point of the feasibility study. Detailed and realistic financing analysis are requisite before high-speed rail can be implemented.

Although changes in the municipal bond market and the tax code have hampered the potential advantages of organizing a high-speed rail system as a public body, some practical benefits remain, such as the power of eminent domain. The commission's consultants have studied the benefits and drawbacks of structuring the system as a public, private or joint public-private entity. Without a detailed project proposal, no firm conclusion can be drawn, but a public body would be an appropriate means by which to begin the project.

The financial consultants' findings are summarized in the following tables:

Maglev Alternative (Option 1)

(See Editor's Note at the beginning of this section)

Route length:	315 miles, all double guideway
Maximum speed and end-to-end trip time:	250 mph; 2 hours, 1 minute
Target construction cost estimate:	$10.311 billion (1986 dollars, "most probable scenario")
Design and construction period:	12 years
First year of operation:	2000
Estimated ridership, first year:	6.9 million trips
Passenger revenues:	$211 million (first year, in 1986 dollars)
Total revenues:	$224 million (first year, in 1986 dollars)
Operation/maintenance cost:	$104 million (first year, in 1986 dollars)
Margin available for debt service:	$120 million (first year, in 1986 dollars)
Margin available for debt service:	$238 million (in 2000, in current dollars)
Total debt outstanding:	$27 billion
Annual debt service:	$1.97 billion (in 2000, in current dollars)
Debt service deficit:	$1.732 billion (2000, in current dollars)
Financial performance:	(Insufficient sources identified to close gap. Operating margin less than debt service requirement until 2027, bond retirement date. Cumulative operating deficit: $25 billion.)
Annual construction/operating period jobs:	25,000/8,300 (direct and indirect)
Total economic benefit (personal income):	$9.4 billion (in 1986 dollars, over construction and 30-year operating period)
Total construction expenditures:	$22 billion (in 1986 dollars)
Increased state tax revenues:	$882 million (in 1986 dollars, over construction and 30-year operating period)
Increase in employment growth rate:	70 percent/22 percent (construction period/operating period)

Very High Speed Steel-Wheel Alternative (Option 2)

(See Editor's Note at the beginning of this section)

Route length:	315 miles, all double track
Maximum speed and end-to-end trip time:	180 mph; 2 hours, 41 minutes
Target construction cost estimate:	$6.998 billion (1986 dollars, "most probable" scenario)
Design and construction period:	10 years
First year of operation:	1998
Ridership, first year:	6.0 million trips
Passenger revenues:	$185 million (first year, in 1986 dollars)
Total revenues:	$190 million (first year, in 1986 dollars)
Operating and maintenance cost:	$105 million (first year, in 1986 dollars)
Margin available for debt service:	$85 million (first year, in 1986 dollars)
Margin available for debt service:	$153 million (in 1998, in current dollars)
Total debt outstanding:	$18 billion
Annual debt service:	$1.34 billion (in 1998, in current dollars)
Debt service deficit:	$1.255 billion (1998, in current dollars)
Financial performance:	(Insufficient sources identified to close gap. Operating margin less than debt service requirement until 2027, bond retirement date. Cumulative operating deficit: $17 million.)
Annual construction/operating period jobs:	22,600/8,000 (both direct and indirect)
Total economic benefit (personal income):	$8.0 billion (in 1986 dollars, over construction and 30-year operating period)
Total construction expenditures:	$16 billion (in 1986 dollars)
Increased state tax revenues:	$755 million (in 1986 dollars, over construction and 30-year operating period)
Increase in employment growth rate:	62 percent/22 percent (construction period/ operating period)

Electrified Steel-Wheel/Steel Rail (Option 3)

(See Editor's Note at the beginning of this section)

Route length:	340 miles (double track east of Harrisburg, single and double west of Harrisburg)
Maximum speed and end-to-end trip time:	50 mph; 3 hours 43 minutes
Target construction cost:	$2.55 billion (1986 dollars, "most probable")
Design and construction period:	6 years
First year of operation:	1993
Ridership, first year:	4.4 million trips
Passenger revenues:	$121 million (first year, in 1986 dollars)
Total revenues:	$145 million (first year, in 1986 dollars)
Operations/maintenance cost:	$98 million (first year, in 1986 dollars)
Margin available for debt service:	$47 million (first year, in 1986 dollars)
Margin available for debt service:	$68 million (in 1994, in current dollars)
Total debt outstanding:	$4.4 billion
Annual debt service:	$323 million (in 1994, in current dollars)
Debt service deficit:	$276 million (in 1994, in current dollars)
Financial performance"	(Operating margin exceeds debt service requirement in 2006, 13th year of operation. Cumulative cash flow after debt service is positive $14 billion by 2027, bond retirement date.)
Annual construction/operating period jobs:	13,000/7,600 (both direct and indirect)
Total economic benefit (personal income):	$5.34 billion ($1.39 billion during six-year construction; $3.95 billion during 30-year operation) in 1986 dollars.
Construction period expenditures:	$6 billion (in 1986 dollars)
Increased state tax revenues:	$492 million (in 1986 dollars, over construction and 30-year operating period)
Increase in employment growth rate:	37 percent/21 percent (construction period/ operating period)

STATION DEVELOPMENT

While a proposed high-speed rail system itself -- its speed of operation, safety, comfort and ease of use -- would be the main element by which patrons judge the system, stations are next in importance because they facilitate the passengers' access and set the tone for the travel experience. They determine how convenient, how secure, how comfortable and how visually pleasing that experience will be. This contributes to how the system is perceived compared to other competing modes of transportation, which in turn helps determine the degree to which the system will be patronized. Stations also can serve as interchange points among various transportation modes, and by their design can either help or hinder the effectiveness of transfers.

The range of station concepts and existing facilities along the Pennsylvania high-speed corridor is wide, encompassing totally new structures as well as adaptive re-use of registered historic landmarks. In all cases, the stations would be built or adapted to provide the same level of service throughout the system. This would include airport-style ticketing and baggage desks and a passenger boarding lounge, retail areas and car rental booths.

Parking has been heavily stressed in this feasibility study. This stems from a belief that any new rail system must facilitate access by motor vehicles -- private autos, rental cars, taxis, buses -- to be successful. In addition to envisioning expanded parking facilities near stations in all of the cities along the proposed route, a consultants' report recommends two additional strategies: Improving intracity transportation links to the stations, specifically public transportation and street networks; and encouraging development of long-term budget lots, similar to those at airports, outside city fringes with easy access to the stations made available by a private and/or public transportation shuttle.

Conceptual designs were drawn up for each of the proposed stations along the route. In some cases they involved modification of existing facilities and, in others, construction of entirely new stations.

Philadelphia

Amtrak's 30th Street Station is the logical eastern terminus for a Pennsylvania high-speed system. Opened in 1933, it serves Amtrak's Boston-Washington Northeast Corridor as the major Philadelphia station for intercity rail travel. Also, it will be the terminus for Atlantic City rail passenger service when it resumes, under Amtrak jurisdiction, in 1989. In addition, 30th Street Station serves all regional commuter rail service operated by the Southeastern Pennsylvania Transportation Authority, including direct service to Philadelphia International Airport; SEPTA local subway and subway-surface lines; and SEPTA bus service. Further, it is located next to the Schuylkill Expressway (I-76), and Market Street offers direct access to Center City.

Philadelphia is estimated to generate the greatest number of system users -- 8,700 to 9,798, daily. Two concepts were proposed for accommodating high-speed rail at 30th Street Station. One would acquire from Amtrak the use of lower-level Tracks 9-12 and occupy 43,000 square feet of the northwest corner of the ground floor. This plan would cost $26.4 million to $29.4 million. The other plan would involve construction of two barrel-vault sunlight canopies adjacent and parallel to the upper-level commuter tracks. Station services would occupy 43,000 square feet of the northeast corner of the ground floor.

Paoli/Great Valley

A new facility would be required at Paoli/Great Valley, a few miles west of the existing commuter station in Paoli proper. The new location would be west of Malvern and offer more space for parking, direct access to the Route 202 office park corridor and the Pennsylvania Turnpike. It would contain an integral five story, 1,300 car parking structure. Costing $10.2 to $11.2 million, it would handle 1,697 to 1,883 daily patrons. The layout and configuration of tracks and platforms could accommodate an extension of SEPTA's Paoli Local service on the outside tracks and high-speed trains on inside tracks, facilitating transfers.

Lancaster

Consultants recommend using the existing Amtrak station at 53 McGovern Avenue, with minor modifications. In use continuously by the former Pennsylvania Railroad, Penn Central and Amtrak for more than 50 years, it is a historic structure that was rehabilitated a few years ago; its historic character would be retained. Modifying the structure for high-speed rail use would cost $7.9 million to $11.1 million. It would handle 985 to 1,640 passengers daily. A proposed new six story, 600 car parking facility would be tied to the complex with overhead walkways.

Harrisburg

As with Lancaster, the Harrisburg station would be adapted for high-speed use. Listed on the National Register of Historic Places, it was built in 1887 and includes two architecturally significant Fink Truss trainsheds; its historic character would be retained. It was renovated in 1982-86 at a cost of about $13 million. Expected to handle 1,813 to 1,824 high-speed patrons daily, the station would be modified at a cost of $4.8 million to $4.9 million. Moving sidewalks would connect the station with existing nearby parking garages and with a proposed new parking facility southeast of the station. Inside, escalators would carry passengers from the lobby level to platform level.

State College

State College is the only community on the proposed route that is not now served by passenger trains. A proposed station, situated southwest of the borough near the junction of Routes 26 and 45, would be built at a cost of $9.3 million to $9.6 million. The all-new, three level intermodal facility would handle 1,186 to 1,235 passengers daily. In addition to the station structure, the complex would include two parking lots with space for 137 cars and space for two four-story garages, each with space for 356 cars.

Lewistown

At the time it was drawn up, the Lewistown station concept was based on the notion that it would be an alternative to a station in State College if the route alignment did not serve Centre County. (Subsequent alignment investigations considered the possibility of routing the system through both communities.) Costing $6.9 million to $8 million, the Lewistown station would be situated near Juniata Terrace. It would serve an estimated daily patronage of 1,000 to 1,042 users. The existing Lewistown station, built about 1849, is being converted to a railroad archive storage facility and is inadequate to serve the needs of a high-speed system. Parking spaces would be provided for 750 to 832 cars.

Altoona

The new transportation center in Altoona, built in a portion of a parking garage at 10th Avenue and 13th Street and opened just a few years ago, would form the basis for a high-speeed station. Modifications costing $3.5 million to $3.8 million would be made to handle an estimated 959 to 967 passengers a day. A new, widened passenger bridge above 10th Avenue and the Conrail main line would carry passengers to escalators leading to a new passenger platform on the southwest side of the freight line.

Johnstown

The existing Amtrak station on Walnut Street, built in 1916, could be modified for high-speed system use at a cost of $5.9 million to $6 million. A daily total of 1,238 to 1,259 passengers is projected. A multi-story parking garage is recommended for a site east of the station, and additional parking could be located on the south side of Walnut Street. Nearby real estate could be developed for hotel/convention, office and retail use.

Greensburg

A new station could be built off College Avenue along Ehalt Street, just west of the existing Amtrak station. Estimated to handled 2,215 to 2,243 passengers daily, the multi-story facility would cost $16.6 million to $16.8 million. A new parking facility, with space for 880 cars, could be built across Ehalt Street and connected to the station via an overhead walkway.

Pittsburgh

Two sites were examined for a potential high-speed terminus in Pittsburgh. The Downtown site - the former Pennsylvania Railroad Station at Grant Street and Liberty Avenue -- would involve modification of a historic structure, at a cost of $18.2 million to $19.8 million. The other possibility lies in a site on the South Side, adjacent to the Station Square office/retail complex. While the Pennsylvania Station site would cost less and would be advantageously located, the Commission voted to favor the Station Square

site for a number of reasons, chief among them being the difficulty of routing a new high-speed alignment to Pennsylvania Station. The access from Wilkinsburg to Downtown is extremely constricted by Conrail's freight main line and by the Port Authority's East Busway (p. 49). An all new three story Station Square structure, costing \$56.1 million to \$57.8 million, would be built along the base of Mount Washington parallel to Carson Street. An estimated 8,044 to 8,508 passengers a year would use the Pittsburgh station. Easy connections could be made with the Port Authority's light-rail transit system, PAT buses and the Monongahela Incline. Walkways would connect the station with the Commerce Court office complex and with parking facilities.

ROUTE ALIGNMENT

The selection of route alignment will, more than any other aspect, affect the overall cost and financial feasibiilty of the system. It also will represent a series of compromises. The shortest possible route, a theoretical straight line between Philadelphia and Pittsburgh, would bypass many of the state's cities and population centers. That would dilute its social value, and Pennsylvania's mountainous topography would render it too expensive to construct. The least expensive choice, doing nothing at all, leaves only the existing trackage whose right-of-way was surveyed in the 1830s and 1840s. This route contains 392 curves, 40 grade crossings, two tunnels and 593 bridges. Currently, maximum speeds on this alignment are 90 mph between Philadelphia and Harrisburg, and 70 mph between Harrisburg and Pittsburgh. Particularly on the latter segment, frequent heavy freight traffic at 35 mph average speeds prohibits the introduction of true high-speed service on the same trackage. Even if the current route could be theoretically cleared of freight trains, the state's topography presents obstacles. Laid out along winding river valleys, this alignment, unaltered, contains curves too numerous and sharp to allow world-class speeds (150-250 mph) that can attract enough passengers to make high-speed rail a commercial or technical success.

In between the theoretical straight line and the existing curving alignment fall a wide range of possibilities. The less capital invested, the more circuitous will be the routing and the slower will be the service, and the fewer passengers will ride the system. While easier to implement, it will yield weaker overall economic benefits to the state in terms of direct and indirect employment and support for Pennsylvania's traditional railroad supply industry. Sales tax and income tax revenue will be more modest.

On the other hand, the greater the investment in right-of-way, the straighter will be the routing, the faster will be the service, and the more passengers will ride. At the same time, the economic impact on the state will be greater. More people will be employed in direct and indirect jobs, more money will flow to suppliers and more tax revenue will be generated. (Note: The German maglev proposal may be an exception to this in that it proposes a somewhat different right-of-way with no tunnels.)

The following description outlines an optimum-performance routing drawn up by the commission's engineering consultants. It should be read only as an example of a high-performance alignment, not as the only route or even as the recommended route. The commission's oversight consultants, as well as engineers representing the French and West German technology suppliers, have made suggestions for substantial changes and route alterations that could reduce the amount of tunneling and other excavation needed, thereby reducing overall capital construction costs by a significant amount. For example, a relatively simple realignment of the right-of-way near Marysville could eliminate a major tunnel, saving about $200 million. Further, a single alignment was proposed for both the steel-wheel and maglev options, with variances between the two presented only as vertical deviations to account for the maglev's higher grade-climbing ability. No options were presented that would have used the steel-wheel vehicle's ability to negotiate curves of smaller radius than maglev -- otherwise known as horizontal deviations in alignment. Finally, whether for steel-wheel or maglev, only a single alignment option was presented. An informed public policy decision requires that several options, with their costs and performance criteria, be considered. Not all of the characteristics of the alignment presented here must be used to implement a successful high-speed rail system. However, the more of this kind of alignment that can be incorporated into a final design, the better will be the overall train performance. Ultimately, for the reasons stated above regarding performance optimization at the best cost, a reworked alignment will have to be drawn. This work would have been required in the final phase of the feasibility study in any event.

The alignment proposal presented here uses new track or guideway on existing right-of-way in several locations: Between Philadelphia and Paoli, through the settled residential and commercial centers of intermediate cities, and on the approach to Pittsburgh. Elsewhere, it uses an all-new alignment. Like the French TGV system, on which high-speed trains use existing

conventional trackage for about 18 miles south of Paris and for several miles north of Lyons, this method has been devised as a means of keeping down capital construction and real estate acquisition costs, and on reducing the amount and severity of disruption to residential areas.

This proposed alignment was developed in preliminary form by consultants to the commission. Conrail provided comments to the consultants indicating that the Conrail right-of-way in areas at Huntingdon, Altoona, Hollidaysburg, and Johnstown might be insufficient to accommodate the proposed high-speed passenger system facilities. With the reduction in the commission's funding, the consultants were unable to deal with right-of-way issues raised by Conrail.

Philadelphia-Great Valley/Paoli (Milepost 0 to Milepost 24.6)

The high-speed system's Philadelphia terminus would be at Amtrak's 30th Street Station. Either a dedicated set of the lower-level platforms or a proposed new upper-level boarding area, to be built north of commuter platforms A-B-C, could be used (p. 37). Travelers boarding or leaving high-speed trains at Philadelphia have easy access to or from Amtrak Northeast Corridor trains; Southeastern Pennsylvania Transportation Authority commuter trains, which operate to the suburbs, to Philadelphia International Airport, and to Center City; Amtrak service to Atlantic City, N.J., and local bus, subway and taxi service.

Between Philadelphia and Paoli, a high-speed line would have to be located on the alignment of the existing Amtrak route. No other option is esthetically, socially, politically, or financially acceptable. Because of the built-up residential areas, it would be prohibitively expensive to create an all-new alignment in this segment. The center two tracks of the four-track line would be upgraded and designated for exclusive high-speed use. Some issues have not been addressed, such as providing lateral clearance and inter-track fencing between the existing suburban-train trackage and high-speed trackage. In addition, existing interlockings (series of safety-interconnected switches and signals at a junction point) at Paoli, Bryn Mawr and Overbrook would have to be reconfigured. How this would be done and who would control them, and under what circumstances they would be used by non-high-speed trains, have not been determined.

For maglev operation, a double-decked structure (one guideway at ground level, one above) down the center of the right-of-way would be needed, because adequate space is not available for twin side-by-side guideways, and single guideway operation would hamper operational flexibility and reliability. The existing overhead-wire catenary system would have to be rebuilt to maintain commuter service, and other accommodation would have to be made for commuter and freight service, specifically, on the issue of maintaining crossover movements between east and westbound trackage.

Because of limited space and parking facilities at the existing SEPTA Amtrak Paoli station site, a new station location west of Paoli, to be titled Great Valley/Paoli, would be established as a Philadelphia-area suburban station (p. 37). This would be located at the point at which Amtrak's main line now crosses Route 202. Another reason for this placement is that Route 202, which connects West Chester with King of Prussia, is becoming a center for new large-scale employment, much of it in technological research and development.

Great Valley/Paoli-Lancaster (Milepost 24.6-63.7)

While other segments of the proposed right-of-way represent challenges of a technical nature, this section represents a challenge of a social/political nature. As highway planners have found to their dismay, plotting a major new expressway through prime Lancaster County farmland is sure to generate substantial local opposition. From a land-use standpoint, high-speed rail technology enjoys two benefits over highways. First, the right-of-way width requirement for a double-track ground-level steel-rail system is about 75 feet, compared to a recommended 200 to 300 feet for a four-lane limited-access roadway. Second, the favored configuration for maglev guideway is that of an elevated structure, which allows farming to continue beneath. In fact, at the Transrapid International test track in Emsland region of West Germany, farming continues uninterrupted below the elevated guideway, the only "footprint" left on the landscape being the pylons that support the guideway beams.

If community sentiment allows either the 75-foot-wide steel-rail alignment or the elevated guideway, a straightened, higher-performance route can be pursued. If not, a lower-performance

route can be plotted on and near the existing Amtrak main line.

Large sections of the Amtrak alignment have been in place since the 1830s and thus have a long-established community acceptance. Currently, Amtrak operates at 90 mph on stretches of this line. This is among the fastest Amtrak service in the nation, exceeded only by 125 mph in the Northeast Corridor and by 110 mph on the Empire Corridor between New York City and Albany. Realignment of some curves on the existing alignment would allow speeds of well over 100 mph perhaps reaching as high as 150 mph in places, for significant portions of the line between Great Valley/Paoli and Lancaster.

If, however, a public policy debate generated a consensus to allow a wholly new alignment, higher speeds can be pursued, with attendant higher costs of investment and greater economic benefit. In laying out a preliminary alignment proposal for this all-new alignment, a serious effort was made to reduce community impacts and, as much as possible, to minimize cutting through prime farmland. Approximately 2.46 miles west of the proposed new Great Valley/ Paoli station, near Whitford, the new high-speed alignment would diverge to the north, crossing Whitford Road, Clover Mill Road, Conrail's former-Reading Company Chester Valley branch, two creeks and the divided lanes of Route 30.

The line would then cut through a knob of North Valley Hills, staying as far from housing developments as possible, and staying north of Northwood Cemetery. A large viaduct would be required to span the East Branch of Brandywine Creek and Creek Road, which lie in a deep ravine (Conrail's former Reading Company branch in this valley has been abandoned). The line would climb a 2 percent grade, cross a viaduct and be routed to take as few residences as possible in the East Brandywine Hills. Bridges over the right-of-way would be required for local streets and for Route 322.

After crossing the Baron Hills at ground level, the proposed alignment curves southwest and crosses from Chester County to Lancaster County, skirting the south slope of Welsh Mountain. It proceeds west for 19 miles, crossing over Peters Road at Milepost 50, running north of Salisbury Heights and Intercourse and south of Mount Airy and Laurel Hill. The line merges with Amtrak's right-of-way about two miles west of Bird-in-Hand, near Witmer, or about 3.7 miles east of Lancaster station. The high-speed rail proposal envisions using the existing Amtrak Lancaster station, with improvements and expanded parking facilities (p. 37).

Other routes, including a southerly course through Downingtown, Coatsville and Parkesburg, and a northerly route, were investigated; they are either more circuitous or costly, or would introduce a greater community impact.

Lancaster-Harrisburg
(Milepost 63.7-98.1)

For about three miles west of Lancaster station, the high-speed rail alignment stays within the Amtrak right-of-way. The new route would diverge from the Amtrak line just west of Flory Mill and would quickly climb a grade to clear Route 283, then return to ground level. New overhead bridges would be required for Route 722 and several local roads.

A 15-mile-long tangent (straight track) between Flory Mill and the Lancaster County-Dauphin County line appears to be feasible; the only community affected along this route is Milton Grove, which is situated just south of the proposed line. From this point to the Pennsylvania Turnpike, another six-mile tangent could be built at ground level. The line would cross the Turnpike on an elevated structure about 2.3 miles east of Middletown. A second structure would be needed to cross Route 283 at the 283-Turnpike overpass, then the line would closely follow the Turnpike's westbound shoulder for about three miles, crossing Swatara Creek and the Middletown & Hummelstown Railroad. It then would recross the Turnpike near Meade Heights.

The new alignment would avoid Highspire, being routed north of the borough and just south of Interchange 19, where it would again cross the Turnpike. It would then cross the Bethlehem Steel Co.'s slag dump and Front Street (Route 230) before merging with the Amtrak right-of-way just east of Steelton, 3.4 miles east of Harrisburg station. Several alternative alignments through the Middletown-Highspire area were considered. The proposed alignment provides the highest performance with the least community impact of any of the alignments identified. The proposed line would allow unrestricted speed throughout, would not require any tunneling, and would have many fewer community impacts than earlier proposals. However, as with the Great Valley/

Paoli-to-Lancaster section, there could be local opposition to building a new line through Lancaster County farmland if care is not taken to mitigate local impact. At Harrisburg, the system would use the existing Harrisburg Transportation Center (p. 37). This 1887 facility, the former Pennsylvania Railroad Station, was renovated in 1982-86 at a cost of $13 million. The space offered in station facilities, parking capacity, track and platform capacity all appear to be adequate for high-speed rail service. From an elevation of about 50 feet above sea level at Philadelphia, the alignment has risen to about 300 feet at Harrisburg, a modest rise over a distance of not quite 100 miles.

* * *

For most of the route of the proposed high-speed rail system, the consultants have worked on a route selection premise contained in the original Request for Proposals. That understanding was that the line should service the cities established along the historic Pennsylvania Railroad main line, a primary artery of settlement and national westward expansion in the 19th century. Partly because of the travel and commerce patterns set up by the PRR, the majority of the state's population lives in the geographic lower third of its boundaries.

One deviation from this route path was added to the study's scope after work began. It involves the possible rerouting of the line northward, through State College and Centre County. The addition was initiated because this area is a growing population center, and because it is the home of Penn State University and an expanding research community. It is, in fact, a recently designated Standard Metropolitan Area, and it currently suffers from inadequate transportation access. This section details a proposed route through State College. Another alternative, to be discussed later, bypasses State College but services it through highway connections at Lewistown or Altoona.

Advantages of routing the system through State College are:

- State College and the Centre Region are among the fastest growing population regions of the state.
- A State College station links the state's two largest business and commercial centers with a research and scientific center.
- A State College station opens opportunities for regional scientific/research conventions and seminars.
- Access to Interstate 80 opens up the state's vast recreational areas. It also widens the geographic area of potential ridership by bringing access to the system closer to communities along and north of I-80.
- The route provides a reliable, all-weather connector to the growing State College area with minimal environmental disruption.

Disadvantages of a State College route are:

- It is possible that the increased capital budget required for the rerouting ($1.15 to $2.16 billion) would prevent a successful financing plan from being developed.
- The lowest cost alternative significantly increases the trip time to nearly four hours. It is not clear whether this routing would permit successful financing of the project.
- The all-new link gains 3.9 percent in ridership initially for an increase of what, in some construction scenarios, could be as much as 85 percent of overall project costs. This would adversely affect the financing of the project.
- The minimum new link (low-performance) gains 1.1 percent in ridership initially for an increase of what could be as much as 45 percent in overall project costs. This would adversely affect the financing of the project.

A description of the Harrisburg-State College-Altoona route is presented, followed by the alignment that skips State College.

Harrisburg-State College (Milepost 98.1-173.7)

From Harrisburg, the route follows the east bank of the Susquehanna River north to Rockville, at which point it crosses the river to the north end of Marysville on a 1.5-mile-long structure on a 9,100-foot-radius curve, which would permit 150 mph operation. Passing from Dauphin County to Perry County, the line then would cross over the Conrail main line and Routes 11-15 and enter a

2.8-mile-long tunnel up a 2 percent grade at the base of Cove Mountain. No better high performance alignment alternatives were identified for this segment of the route. This is an area where a lower performance route alternative might save hundreds of millions of dollars. However, this is one of the most challenging pieces of terrain in the entire route, and a viable lower-speed route may be difficult to identify.

West of Marysville, the proposed route follows an 11-mile straight line with virtually no grades through the rugged foothills of Cove Mountain. A 2,100-foot-long tunnel would be required under Pisgah Ridge, followed by a high elevated structure over Sherman Creek. At this point, the route curves northward through rugged terrain crossing Routes 74 and 850 between Landisburg and Alinda and Route 274 east of Loysville. It crossed Limestone Ridge at ground level, then proceeds to a tunnel beneath Bilman Ridge (4,000 feet long for the steel-wheel alternative and 3,500 feet long for the maglev alternative). The route then would pass west of Ickesburg, crossing Route 17, before entering a 3.25-mile-long tunnel under Tuscarora Mountain, a 1,300-foot-high ridge that cannot be avoided without adding many additional miles of route and imposing speed-restricting curves. Beneath the mountain, the line passes from Perry County to Juniata County. Once north of Tuscarora Mountain, the route gently winds its way west of Port Royal and Mifflin, crossing Routes 75 and 35, to Denholm. From there, the State College-bound line crosses the Juniata River and through a 2.25-mile-long tunnel under Shade Mountain, passing from Juniata County to Mifflin County. (The alternative route diverges from the State College route at Denholm.)

The alignment cuts through several ridges northwest of Shade Mountain, approaching Jacks Mountain. If a Lewistown stop is implemented with this alignment, the station would be built at this point, along Route 522 near Maitland. A 2,300-foot-long tunnel would be required under Chestnut Ridge to minimize the impact to Pleasant Valley and to avoid rerouting several local roads. A 1.8-mile-long tunnel would be needed through Jacks Mountain, a 1,200-foot-high ridge that cannot easily be avoided.

A major 5.6-mile-long tunnel under Broad Mountain would be required, entering just north of Milroy and exiting just east of Colyer Lake. While in the tunnel, the route would cross beneath Route 322, and would pass from Mifflin County to Centre County. The line then would head almost due west along the south slope of Tussey Mountain, crossing Route 45 near Shingletown, to the site of a proposed new station, which would be built in the vicinity of the Routes 26 and 45 intersection. Several other possible routes were considered, including some totally different approaches to Penns Valley. Each was either excessively circuitous and speed-restricting, or had unacceptable environmental impacts.

State College-Altoona
(Milepost 173.7-209.6)

The proposed route proceeds almost due west from State College station through the Barrens, staying south of the state game lands. Either a 200-foot-deep cut or a 4,500-foot-long tunnel would be required to cross Bald Eagle Mountain. In either case, at an elevation of about 1,450 feet, this would be the highest point between Philadelphia and Altoona, where the alignment begins to climb an even higher series of ridges and mountains. A long 3.5 percent grade down the western slope of Bald Eagle would lead to the valley floor, where the alignment would parallel the right-of-way of the former Bald Eagle Branch, now the Nittany & Bald Eagle Railroad. The line would pass from Centre to Blair County northeast of Bald Eagle. It then would cross beneath new Route 220 just south of Bald Eagle, and cross over old Route 220 near Vail. (The alternative route rejoins the State College route at Vail.) From there, it would rise along a hill west of Tyrone, just south of the Tyrone Reservoirs, then curve gently southward toward Bellwood, crossing Route 453. A long deep cut or a 4,700-foot-long tunnel would be required through a hill west of Hutchinson Run.

The alignment would cross above the Conrail main line just south of Bellwood and run parallel to the main line, along the southeastern side of the yards, to downtown Altoona. The elevation here is about 1,100 feet. A new station platform would be built across the main line from and linked by overhead enclosed walkway to the new Transportation Center between 12th and 13th streets.

Lewistown Alternate: Deholm-Vail
(Milepost 00.0-61.0)

At Denholm, the alternate alignment diverges from the State College alignment. It follows the Juniata River valley southwestward through the

Lewistown Narrows, passing from Juniata County to Mifflin County. A five-mile loop deviation (Milepost 6 to 11) would be constructed to place a Lewistown station stop in a location accessible not only to the town but also to highways leading from State College and other parts of the midstate area.

The Lewistown station would be built south of the borough of Juniata Terrace adjacent to Route 333. A portion of the loop would fall within the existing Conrail right-of-way. The proposed line crosses Route 103, the Conrail main line and the Juniata near Ryde and climbs Sandy Ridge. It then crosses a new aerial structure above the Conrail mainline (at Conrail milepost 183, or an S-curve track landmark railroaders call "the figure 8"), but stays north of the main line. The high-speed route then follows a straight line to Newton Hamilton, where it roughly follows the Conrail right-of-way for about three miles into Mount Union. Here it crosses the Juniata again, passing from Mifflin to Huntingdon counties. Still along the Conrail right-of-way, it crosses Route 522 and proceeds west through Jack's Narrow, adjacent to the Conrail line. It curves right on an elevated structure over the Juniata, over Route 22 and back, over the quarry, recrossing the river and Route 655, and over Conrail again, headed northwest toward Huntingdon.

The route then runs along the southern bank of the river, crossing the Raystown Branch of the Juniata, to a point near Ardenheim, about two miles southeast of Huntingdon, where it crosses the Juniata and follows the Conrail right of way at ground level through Huntingdon. At Conrail milepost 203.6, it curves left on an elevated structure over the river and up a ravine just north of the state prison. Then it runs at ground level up hill through undeveloped land and in a cut next to an abandoned strip mine. It crosses Route 22 about 1.5 miles southeast of Alexandria, requiring an elevated structure, and runs parallel to the highway for three miles, through a gap near Alfarata. It then crosses over the highway just east of Water Street and runs north at ground level up a hill on the east side of Route 453 (and over Route 45), avoiding agricultural lands.

The proposed alignment skirts past Sinking Valley, running north to cross the Little Juniata River and the Conrail main line near Spruce Creek. It then crosses Route 550, passes from Huntingdon County to Blair County, and curves west through a notch in Bald Eagle Mountain in a cut just east of Vail. The alignment rejoins the State College alignment at Vail, just northeast of Tyrone.

Altoona-Johnstown
(Milepost 209.6-245.0)

The new line would follow Conrail's Hollidaysburg branch right-of-way to a point just north of Duncansville. It would follow the recently constructed new Route 220 through Duncansville for about two miles and then crosses over old Route 220, heading southwest at ground level toward Puzzletown. There, it begins a long ascent following Blue Knob Run. For the steel-wheel alternative, the grade is limited to 5 percent, necessitating a two-mile tunnel beneath Red Cap Hill, just north of the village of Blue Knob. For the maglev alternative, with its greater grade-climbing ability, the tunnel can be avoided. At the west end of the tunnel, the line passes from Blair to Cambria counties and surmounts a peak of 2,500 feet elevation.

A large cut through the top of Portage Hill is required under both alternatives and then a long descending 4 percent grade along Trout Run, crossing Route 164 and passing south of Fiddlers Green and Spring Hill. The line then would proceed west at ground level through rugged terrain. It would cross Route 219 and Conrail's South Fork Branch south of South Fork. A deep cut or a tunnel would be required just south of Wissingertown through a portion of Conemaugh Hill. The decision of whether to tunnel is affected by the hill-climbing capability of the technology used. For the steel-wheel alternative, a tunnel would probably be required. For maglev, a tunnel might be avoided, if the community impact of a large cut is acceptable. A 2,800-foot-long tunnel through a hill just east of Franklin appears to be necessary under both alternatives. The line then crosses the Conemaugh River just north of Franklin and over the Conrail main line, returning to ground level and following the Conrail right-of-way for three miles to Johnstown station, at an elevation of about 1,200 feet. The study assumes the use of the existing former Pennsylvania Railroad station at Johnstown.

Johnstown-Greensburg
(Milepost 245.0-280.0)

The alignment follows the Conrail right-of-way for about a half-mile west of the station and then diverges west up Brownstown Hill. A series of short tunnels or high retaining structures would be required to minimize the effects of con-

structing the line through the western suburbs of Johnstown. The line skirts north of Brownstown, then heads southwest up and over Laurel Hill. Three tunnels totaling about three miles in length would be required, the second of which would represent the highest point on the alignment, at 2,600 feel elevation. At the same point, the line passes from Cambria County to Westmoreland County, then dropping to an elevation of about 1,500 feet. A 10,700-foot-long tunnel would be required beneath the peak of Chestnut Ridge, and the alignment hits another peak, of 2,000 feet elevation, at the west portal of this tunnel. The route passes between Derry and Latrobe, crossing Route 217 and the Conrail main line, running south of an abandoned railroad grade. It then curves south to connect with the Conrail main line right-of-way about 1.5 miles east of Greensburg, and follows it into the downtown area at an elevation of about 1,100 feet. The study projects the construction of a new high-speed rail station immediately west of the existing former Pennsylvania Railroad station.

Greensburg-Pittsburgh (Milepost 280.0-314.6)

The proposed alignment diverges from the Conrail right-of-way immediately west of Greensburg station through a 2.5-mile-long series of three tunnels, one of which carries the line beneath Route 30. The line then proceeds due west through Hempfield Township, staying as far as possible from developed areas. It crosses the Turnpike about 1.5 miles south of the Irwin Interchange. The route passes just south of Sunset Valley through a 2,900-foot-long tunnel and then due west, crossing over the CSX Transportation (former Baltimore & Ohio Railroad) main line and the Youghiogheny River in South Versailles, passing from Westmoreland County to Allegheny County. It then joins the Pittsburgh & Lake Erie Railroad's Youghiogheny Division (Connellsville to McKeesport) right-of-way at milepost 294, north of Coulter and east of Boston. After following the P&LE right-of-way for about 6.5 miles, the proposed line crosses the Youghiogheny and Monongahela rivers at their confluence at the edge of McKeesport. The line then follows the Union Railroad right-of-way, through Duquesne, for about 8.5 miles to Homestead. At this point the line would diverge from the P&LE alignment and follow the Conrail right-of-way to a new station to be constructed at the base of Mount Washington on vacant land above West Carson Street, at an elevation of about 800 feet. A new large parking garage would be constructed.

For a number of reasons, the commission elected to favor a South Side site near the Station Square office/retail redevelopment complex as the western terminus for high-speed rail service. While Pennsylvania Station at Grant and Liberty is advantageously located in the city's downtown area, railroad access to it is severely choked. Between Swissvale and downtown, construction of a busway has taken land formerly occupied by two main line tracks. The constricted access remaining is occupied by two Conrail main line tracks. Short of Conrail rerouting its freight trains and allowing the double-track access to be taken over by a high-speed rail system, there appears to be little means to create an acceptable, affordable high-speed rail access to Pennsylvania Station. In the case of steel-wheel technology, mixing freight and high-speed passenger service on the same trackage is considered to be counter to the aims of this system. It creates dispatching conflicts and sets up difficulties in engineering signal installations. Other alternatives -- tunnels or overhead structures -- were rejected as impractical or too costly. Overhead structures, including the maglev elevated guideway, might be possible but that option is complicated by the existence of numerous overhead bridges crossing the Conrail/busway corridor.

ENVIRONMENT

This section briefly describes the environmental review process that a Pennsylvania high-speed rail project would be required to undertake and evaluates, in a general way, the likely environmental effects alternative high-speed technological approaches would induce.

Congress and state legislatures have enacted extensive legislation during the last several decades designed to protect and enhance the environment. The result is that governmental agencies and organizations, as well as the private sector, are required to create and maintain environmental standards recognizing present and future ecological and social needs.

The National Environmental Policy Act of 1969 (NEPA), in particular, established broad national environmental goals. Two major developments resulted from this act: (1) the Council of Environmental Quality (CEQ) was established to provide general oversight of national policy, and (2) Section 102(2)(c) of NEPA specifically requires preparation of a comprehensive Environmental Impact Statement (EIS) for every federal action significantly affecting the quality of the environment. In Pennsylvania, Legislative Act 120 established procedures for the environmental review and approval process for transportation projects. In addition to the broad policy objectives established by NEPA and Pennsylvania Act 120, a multitude of federal and state legislative and regulatory actions mandate specific environmental requirements.

Environmental impacts fall onto these general categories:

- land use and aesthetic intrusion
- noise, vibration and air quality

In addition, water resource, fish, wildlife, historic preservation and public safety issues are often considered in the environmental review process.

Although the ecological effects associated with building and operating a high-speed rail system would be significant, they would be generally less severe than the impacts associated with building new interstates or airports. In virtually all categories -- land required, energy consumption, noise, vibration, air pollution and aesthetic intrusion -- railroads are potentially less damaging to the environment than airports or freeways. The following brief discussion highlights the major impacts and measures that can be taken to minimize them. Also discussed are potential environmental benefits.

Land Use and Aesthetic Intrusion

As with any new transportation system installation, the ecological consequences of building a high-speed rail system would be significant. In areas where all-new right-of-way is needed, some landowners may object to aesthetic intrusion, noise and vibration inherent in the construction and operation of some forms of high-speed systems adjacent to their property, and the resulting effect on property values.

The impacts and intrusions can be minimized by careful site selection and route alignment along existing transportation corridors -- e.g., by paralleling interstate highways or existing rail lines, by installing sound barriers along the right-of-way and incorporating shock-absorbing elements in the design, or by locating the track on an elevated structure or underground. But these measures have limitations. Tunneling can be 10 to 25 times more expensive than at-grade construction, and therefore cannot be used extensively to alleviate environmental impacts. Sufficient land may not be available adjacent to (or in the median strip of) urban freeways to locate the high-speed rail system there, and sound barriers have only limited effectiveness.

One of the more promising mitigation measures involves elevating the system (particularly with maglev technology) so that merely an easement, rather than outright property acquisition, would be required. This configuration would be particularly advantageous through open space and agricultural areas where the high-speed system need not influence present land use. Farming, for instance, could be continued in areas immediately adjacent to the elevated guideway under this approach.

Detailed site-specific trade-off analyses must be conducted and coordinated with local planning authorities and citizen groups to identify an

alignment and design that is environmentally acceptable to potentially affected residents.

Noise, Vibration and Air Quality

All the systems studied use high-technology equipment that is inherently quieter than the majority of existing rail equipment. Tighter construction tolerances for track will tend to minimize wheel/rail noise; electrically powered trains minimize propulsion noise. Any conventional steel-wheel system can produce potentially unacceptable levels of noise at high speeds, but steps can be taken to reduce noise and vibration through the use of continuous welded rail, elastomeric track pads, floating slabs, acoustical barriers. Maglev systems are potentially more attractive environmentally than conventional systems, because there is no contact between vehicle and guideway. In any event, the fact of relatively low frequency -- hourly service in each direction was assumed throughout the study, for example -- means that noise impact should be low.

Air pollution from railroads is not a major problem, especially in electrified operations, where emissions from burning fuel are confined to centralized power plant locations. The level of pollutants emitted to power rail passenger vehicles is minuscule, compared to emissions from other transportation modes, notably highway vehicles. Electric utilities along the right-of-way of the proposed system have enough reserve capacity to supply high-speed rail without requiring construction of new generating stations.

APPENDIX A

PROPOSED LEGISLATION

The commission's consultant on legal and institutional issues provided the following recommended sample or proposed legislation by which to initiate high-speed rail service. Although it was reviewed by the commission in several drafts, no final version was developed or approved.

AN ACT

Creating the Pennsylvania High Spee_ Intercity Rail Passenger Authority; defining the powers, duties and functions thereof; providing for the funding thereof; providing for the incurrence of debt by governmental units; and making appropriations.

TABLE OF CONTENTS

The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

Section 1. Short title. This Act shall be known and may be cited as the "Pennsylvania High Speed Intercity Rail Passenger Authority Act."

Section 2. Legislative findings; declaration of policy.

(a) Legislative findings. It is hereby determined and declared as a matter of legislative finding that:

(1) The development and utilization of a properly designed, constructed and financed high speed intercity rail system can act as a catalyst for employment, economic growth and development, thus benefiting the people of the Commonwealth.

(2) A timely and efficient mode of intercity passenger rail service would provide an essential service to meet the increasing need for transportation by the people of the Commonwealth.

(3) Technological advances in the Commonwealth's rail transportation system can significantly improve the Commonwealth's ability to attract domestic and international travelers, thus significantly affecting the Commonwealth's revenues.

(4) Safe, efficient and economically viable high speed intercity rail passenger service is possible with the encouragement of the Commonwealth.

(b) Declaration of policy. It is hereby declared to be the policy of the Commonwealth of Pennsylvania to develop high speed intercity rail transportation to improve passenger services, create new employment opportunities, provide economic development opportunities and promote the safety, convenience and welfare of its citizens. The Pennsylvania High Speed Intercity Rail Passenger Authority shall exist and operate for the purposes contained in this act, which purposes are hereby declared to be public uses for which public authority may be exercised and public money may be spent and in support of which private property may be acquired by the exercise of the power of eminent domain.

Section 3. Definitions. For purposes of this act the following words and phrases, unless the context clearly indicates otherwise, shall have the meanings ascribed to them in this section:

"Ancillary facilities" shall mean property, equipment or buildings built, installed or established to provide financing, funding or revenues for the planning, construction, management or operation of a high speed intercity rail line. It includes property which will be jointly developed, such as parking lots, stores, retail establishments, restaurants, hotels, offices and other commercial, civic, residential and support facilities. It also includes property necessary to protect or preserve the station area by reducing urban blight or traffic congestion and property necessary to accomplish any of the above purposes.

"Authority" shall mean the Pennsylvania High Speed Intercity Rail Passenger Authority created by this act.

"Bonds" shall mean and include the notes, bonds, refunding bonds and other evidences of indebtedness or obligations which the Authority is authorized to issue.

"High speed intercity rail" shall mean any mass commuting high speed fixed guideway transportation system (capable of safely operating at speeds in excess of 124 miles per hour), including monorails, dual track rails, suspended rails, magnetic levitation systems or pneumatic propulsion systems. The high speed intercity rail system includes a corridor and structures essential to the operation of the line. This includes land, structures, improvements, rights of way, easements, rail lines, rail beds, guideway structures, stations, platforms, switches, yards, terminals, power relays, switching houses, transit stations, transit station appurtenant buildings, ancillary facilities and any other facilities used or useful for the purposes of high speed intercity

rail travel or financing, construction, operation or maintenance of the high speed intercity rail system.

"Revenue" shall mean rents, receipts, purchase payments, grants, gifts, donations, bequests, contributions, proceeds from bonds, appropriations, funds, anything of value; income derived by the Authority from the sale, lease, or other disposition of high speed intercity rail facilities; any value derived by the Authority from joint development and ancillary facilities; land sale value received by the Authority through the sale of developed or undeveloped land adjacent to the route of the high speed intercity rail line; and any interest or income derived from the investment of moneys for any fund or account of the Authority.

Section 4. Establishment of the Authority; board of directors.

(a) Establishment of Authority. There is hereby created the Pennsylvania High Speed Intercity Rail Passenger Authority as a public body corporate and politic, exercising the public power of the Commonwealth. The Authority is constituted an instrumentality of the Commonwealth and the exercise by the Authority of the powers conferred by this act shall be deemed and held to be a public and essential governmental function.

Board of directors. The powers of the Authority shall be exercised by a board of directors composed of the following and adhering to the following rules:

(1) The board shall consist of the chairs and minority chairs of the House and Senate transportation committees, or their successor committees, who shall be ex-officio, nonvoting members and _____members appointed by the Governor by and with the advice and consent of a majority of the members of the Senate. Appointed members shall be residents of the Commonwealth of Pennsylvania at the time of their appointment and qualification and shall also at such time have been qualified electors therein for a period of at least one year preceding the appointments. No more than ____ appointed members shall be from the same political party.

(2) The ____appointed members of the board of the Authority shall continue in office for terms of one year, two years, three years, four years and five years, respectively as designated by the Governor at the time of their appointments, from the first day of January next succeeding the date of approval of this Act. Thereafter, whenever a vacancy has occurred or is about to occur by reason of the expiration of the prior term to succeed the member whose term has expired or is about to expire. Any person appointed to fill a vacancy in an unexpired term on account of resignation, removal or death shall serve for the remainder of that term. Members shall hold office until their successors have been appointed and qualified and may succeed themselves.

(3) The board shall elect one of the appointed members as chair and may also elect a secretary and treasurer who need not be a member of the board of the Authority.

(b) Quorum. A majority of the appointed members of the board of the Authority shall constitute a quorum and all action may be taken by a vote of a majority of members present, unless in any case the by-laws shall require a larger number. No vacancy in the membership of the board of the Authority shall impair the rights of a quorum to exercise all rights and perform all duties of the Authority. Meetings shall be held annually or more frequently at the call of the chair.

(c) Compensation. Appointed members of the board of the Authority shall receive compensation as shall be provided by law but all members shall be entitled to receive reimbursement for necessary expenses incurred in the performance of their duties as members.

Section 5. General powers and duties of the Authority.

(a) The Authority shall have, and members of its board may exercise, any or all of the powers necessary or convenient to carry out the purposes of this act, including, but not limited to, the following general powers:

(1) To sue and be sued in the name of the Authority.

(2) To adopt and use an official seal, alter it, and authorize the use of a facsimile thereof.

(3) To maintain a principal office in Harrisburg and, if necessary, regional offices at locations properly designated or provided.

(4) To make rules to implement and make effective its powers and duties and make or alter by-laws as necessary and proper for the regulation of its affairs and the conduct of its business.

(5) To make and enter into all contracts and agreements and execute all instruments necessary or incidental to the performance of its duties and the execution of its powers.

(6) To appoint an executive director and employ such other staff as is deemed necessary or convenient to carry out the purposes of this act.

(7) To contract for the services of investment banking, financial advisory, legal or other consultants to plan, review, structure or advise the Authority as to requirements associated with the high speed intercity rail system.

(8) To contract for the services of architects, engineers, urban planners, attorneys and consultants of any type in relation to the feasibility, safety or other considerations of high speed intercity rail passenger service.

(9) To purchase property coverage and liability insurance for high speed intercity rail passenger service projects and for any offices of the Authority; to purchase insurance protecting the Authority and its directors and employees against liability to purchase any other insurance the Authority believes prudent or that it agrees to provide under any resolution authorizing the issuance of bonds or in any trust agreement securing the same.

(10) To enter into contracts of group insurance for the benefit of its employees or to continue any existing insurance, pension or retirement system or any other employee benefit arrangement covering employees of an acquired transportation system or set up a retirement or pension fund or any other employee benefit arrangement for such employees.

(11) To acquire by purchase, gift, grant, devise, contribution, exchange or interagency transfer and hold property or any interest therein; title to property so acquired shall be held in the name of the Commonwealth and shall be administered by the Authority.

(12) To receive and accept from the Commonwealth, any Federal agency or other person, subject to the approval of the Governor, grants for or in aid of the construction, repair, renovation or acquisition of intercity rail service projects and receive and accept aid or contributions from any source of money, property, labor or other things of value to be held, used and applied for the purpose for which such grants and contributions are made.

(13) To succeed to all Federal allotments, entitlements, subsidies and grants now existing, whether such allotments, entitlements, subsidies and grants are encumbered or unencumbered, in the same manner and with the same authority as the High Speed Intercity Rail Passenger Commission exercised prior to passage of this act; in regard to high speed intercity passenger rail service, the Authority is the successor to the High Speed Intercity Rail Passenger Commission.

(14) To invest funds not required for immediate use, including proceeds from the sale of any bonds, notes or other obligations in such obligations, securities and other investments as the Authority shall deem prudent.

(15) To lease to or from any person, firm, corporation, association or public or private body, any interest, property or ancillary facilities associated with a high speed intercity rail line.

(16) To contract for services, including managerial and operating services, whenever it can more efficiently and effectively serve the public by doing so rather than by conducting its own operations.

(17) To do any and all things necessary or convenient to carry out its purposes and exercise the powers given and granted in this act.

(18) To do any act necessary or convenient to the exercise of the foregoing powers or reasonably implied therefrom.

Section 6. Special powers and duties of the Authority.

(a) The Authority shall be empowered to exercise any or all of the following special powers and to perform any or all of the following duties to develop, promote and support safe and efficient high speed intercity rail passenger service throughout the Commonwealth.

(b) Development of plan. The Authority shall prepare a plan for the financing, construction and operation of a high speed intercity rail passenger system. The plan for construction and operation shall be based, as much as possible, on existing studies. The system shall include a route to connect Philadelphia, Harrisburg and Pittsburgh and any point between these cities determined by the Authority. The plan shall include the following:

(1) The route alignment of the proposed system.

(2) The proposed technology.

(3) The size, nature and scope of the proposed system.

(4) The sources of the public and private revenue and funds needed to finance the system.

(5) The projected ability of all revenue sources to meet both the capital and operating requirements of the proposed system.

(6) The construction, operation and management plan for the system including a timetable for construction and the proposed location and number of transit stations required.

(c) Financial Responsibilities. The Authority shall be empowered to secure financing necessary to fulfill its duties and responsibilities and has special powers to do the following:

(1) To borrow money from private lenders, the Commonwealth, Federal government, any municipality or others in such amounts as may be necessary or desirable for the operation and work of the Authority; to make and issue negotiable notes, bonds, refunding bonds and other evidences of indebtedness or obligations of the Authority in connection with any such borrowing or refunding or in payment, in whole or in part, for all or any part of any transportation system or any bonds, shares or other securities of any corporation owning or operating any such system or any franchises, property, equipment or interests acquired or to be acquired by the Authority; to secure the payment of such bonds or any part thereof by pledge or deed of trust of all or any of its revenue; to make such agreements with the purchasers or holders of such bonds or with others in connection with any such bonds, whether issued or to be issued as the Authority shall deem advisable; and, in general, to provide for the security for such bonds and the rights of the holders thereof.

(2) To establish or increase reserves from moneys received or to be received by the Authority to secure or pay the principal of and interest on bonds, notes or other obligations issued by the Authority pursuant to this act.

(3) To apply for and to accept grants, loans and other assistance from and to enter into contracts, leases or other transactions with the Federal government or any agency or instrumentality thereof for any of the purposes of the Authority and to enter into any agreement with the Federal government in relation to such grants, loans or other assistance: Provided, that such agreement does not conflict with any of the provisions of any trust agreement securing the payments of the Authority.

(4) To make grants and loans for high speed intercity rail passenger service projects or parts thereof.

(5) To consult with public authorities and private entities and persons in connection with the acquisition, renovation, repair or construction of any high speed intercity rail passenger service project.

(6) To acquire by eminent domain any real or personal property including improvements and fixtures of any kind whatever for the public purposes set forth in this act in the manner hereinafter provided.

(7) To exercise power as a redevelopment authority under the Act of May 24, 1945 (P.L. 991), after consultation with other such authorities, municipalities, counties and political subdivisions in order to provide ancillary facilities and services for high speed intercity rail passengers.

(8) To pledge, hypothecate or otherwise encumber, the revenues of the Authority as security for the obligations of the Authority.

(9) To enter into contracts, leases or other transactions with the Commonwealth, its agencies and instrumentalities, municipalities or corporations or any person whatsoever on such terms as the Authority shall deem proper for any of the purposes of the Authority.

(10) The Authority shall have no power at any time or in any manner to pledge the general taxing power of the Commonwealth nor shall any of its obligations be deemed to be obligations of the Commonwealth nor shall the Commonwealth be liable for the payment of principal or interest on such obligations except as it expressly agrees.

(d) Regulatory powers. The Authority shall exercise the regulatory powers of the Commonwealth with respect to high speed intercity rail passenger service. The Authority is authorized and required:

(1) To act as agent of the Commonwealth or of the Federal government or any of their instrumentalities or agencies for the public purposes set out in this act.

(2) To make available to the government of a municipality or any appropriate agency, board or commission thereof, the recommendations of the Authority affecting any area in the Authority's field of operation or property therein which it may deem likely to promote the public health, safety and welfare.

(3) To review the fixing of rates, fares, charges and marketing practices for high speed intercity rail passenger and related services.

(4) To prescribe, as necessary, appropriate rules, regulations, orders and standards to ensure safety of passengers and employees in relation to the high speed intercity rail passenger system and its equipment.

(5) To regulate the operation of the high speed intercity rail passenger system as necessary and convenient.

(6) To maintain such books and records and to have access to books and records as necessary and convenient.

(7) To conduct examinations and investigations and to hear testimony and take proof under oath or affirmation at public or private hearings on any matter material to the public purposes set forth in this act.

(8) To request data and information from any authority, commission, department or other agency of this Commonwealth to assist it in performing its duties.

(9) To request any railroad, common carrier or public utility to provide it with data and information necessary to carry out the purposes of this act, which requested data and information shall be provided to the Authority. The Authority shall not disclose any confidential data or information supplied to it.

(e) Franchise authority. The Authority is empowered to enter into such agreements as it determines desirable to provide for the construction and operation of the high speed intercity rail passenger system.

(1) The Authority may award an exclusive license to construct or operate any portion of the high speed intercity rail passenger system or any product or service provided in connection with such system.

(2) The Authority may make the award of a franchise subject to such terms and conditions, including the posting of a performance bond for construction and operation of the high speed intercity rail line, as it deems appropriate and consistent with the provisions of this act. The franchise shall list all permits and licenses necessary for the construction and operation of ancillary facilities. All agencies, departments, and other instrumentalities of the Commonwealth and its political subdivisions shall grant and approve all appropriate permits and licenses necessary for the construction and operation of ancillary facilities with terms and conditions consistent with the franchise terms and conditions unless expressly waived or exempted in the franchise.

(3) The award of a franchise shall be for a period from the date of award as provided for in the franchise.

(4) A franchise shall authorize the franchisee to provide services as the Authority shall establish.

(5) A franchisee shall not convey, lease, or otherwise transfer any high speed intercity rail passenger system property, interest in such property or improvements constructed upon such property, to any other party during the term of the franchise, if in the opinion of the Authority, such conveyance, lease or transfer will adversely impact:

(i) the overall quality or level of service;
(ii) the overall financial feasibility of the high speed intercity rail line; or
(iii) the overall continued operation or maintenance of the high speed intercity rail line.

(f) Creation of operational entity. Should the Authority at any time determine that operation and maintenance of the high speed intercity rail passenger system can be more economically and efficiently provided through a for profit corporation, it may establish such an entity under the laws of the Commonwealth.

(1) The incorporators shall be the members of the board of the Authority, who shall take whatever steps are necessary to establish the corporation.

(2) The corporation shall be authorized to issue indebtedness, preferred stock, common stock, contingent interest notes and other securities.

(3) The corporation shall be authorized to own, manage, operate, lease or contract for properties in order to provide safe and efficient high speed intercity rail passenger service.

Section 7. Bonds of the Authority.

(a) Purposes and Powers.

(1) The Authority shall have the power to issue bonds, the principal and interest of which are payable from its revenues generally. Any such bonds may be secured by a pledge of any revenues, including grants or contributions from the Federal or State government, or any agency or instrumentality thereof, or by a mortgage of any property of the Authority.

(2) The bonds issued by the Authority are hereby declared to have all the qualities of negotiable instruments under the merchant law and the negotiable instruments law of the Commonwealth.

(3) The bonds of the Authority created under the provisions of this act and the income therefrom shall at all times be free from taxation for State and local purposes under any law of this Commonwealth.

(4) Neither the members of the board of the Authority nor any persons executing the bonds shall be liable personally on any such bonds by reason of the issuance thereof. Such bonds or other obligations of the Authority shall not be a debt of the Commonwealth and shall so state on their face, nor shall the Commonwealth or any revenues or property of the Commonwealth be liable therefor.

(b) Form and sale of bonds.

(1) The bonds of the Authority shall be authorized by resolution, shall be issued in one or more series, and shall bear such date, mature at such times and bear interest at such rate as shall be determined by the Authority as necessary to issue and sell such bonds. The bonds shall be in such denominations, in such form (including book entires at central depositories), executed in such manner, payable in such medium or payment, at such places and subject to such terms of redemption and such registration privileges as may be provided in the authorizing resolution or in any trust, indenture or mortgage properly made in pursuance thereof.

(2) Bonds shall be executed by a member of the board of the Authority. The bonds shall be signed by such officials as the Authority shall determine. Any such bonds may be issued and delivered, notwithstanding that one or more of the officials signing such bonds shall have ceased to be officials at the time when bonds shall actually be delivered.

(3) Said bonds may be sold at public or private sale for such price and at such rate of interest as the Authority shall determine.

(4) If the Authority shall by official action determine that a negotiated sale of bonds is in the best interest of the Authority, the Authority may negotiate for the sale of bonds with the underwriter or underwriters designated by the Authority.

(5) Any bond reciting in substance that it has been issued by the Authority to accomplish the public purposes of this act shall be conclusively deemed in any suit, action or proceeding involving the validity or enforceability of such bond or security thereof to have been issued for such purpose.

(6) The Authority shall have the power to purchase any bonds issued by it at a price not more than the par value thereof plus accrued interest. All bonds so purchased shall be cancelled. This paragraph shall not apply to the redemption of bonds.

(c) Provisions of bonds, trust indentures, leases and mortgages. In connection with the issuance of bonds or the incurring of obligations under leases, and in order to secure the payment of such bonds or obligations, the Authority, in addition to its other powers, shall have the power:

(1) To pledge revenues to which its right then exists or may thereafter come into existence.

(2) To mortgage its interests, real or personal property then owned or thereafter acquired.

(3) To covenant against pledging all or any part of its revenues; against mortgaging all or any part of its real or personal property to which its right or title exists or may thereafter come into existence; against permitting or suffering any lien on such revenues or property convenient with respect to limitations on its right to sell, lease or otherwise dispose of any of its real property; and to covenant as to what other or additional debts or obligations may be incurred by it.

(4) To covenant as to the bonds to be issued and to the issuers of such bonds, and as to the use and disposition of the proceeds thereof; to provide for the replacement of lost, destroyed or mutilated bonds; to covenant against extending the time for the payment of its bonds or interest thereon; to redeem the bonds, and to covenant for their redemption; and to provide the terms and conditions thereof.

(5) To covenant, subject to the limitations contained in this act, and to the amount of revenues to be raised each year, as well as to the use and disposition to be made thereof; to create or to authorize the creation of special funds for debt service or other purposes; and to covenant as to the use and disposition of the moneys held in such funds;

(6) In the event that the sum of all reserves pledged for the payment of such bonds shall be less than the minimum reserve requirements established in any resolution or resolution authorizing the issuance of such bonds, the chair of the Authority shall certify, on or before the first day of December of each year, the amount of such deficiency to the Governor for inclusion, if the Governor shall so elect, of the amount of such deficiency in the budget to be submitted to the General Assembly for appropriation to the Authority in order to be pledged for payment of such bonds or notes. The General Assembly shall not be required to make any appropriation so requested, and the amount of such deficiencies do not constitute a debt or liability of the Commonwealth.

(7) To prescribe the procedure, if any, by which the terms of any contract with bondholders may be amended or abrogated, the amendments to the bonds which the holders must consent thereto, and the manner in which such consent may be given.

(8) To covenant as to the use of any or all of its real or personal property, to warrant its title, and to covenant as to the maintenance of its real and personal property, the replacement thereof, the insurance to be carried thereon, and the use and disposition of insurance moneys.

(9) To covenant as to the rights, liabilities, powers and duties arising upon the breach by the Authority of any covenant, condition or obligation and to covenant and prescribe, in the event of default, as to the terms and conditions upon which any or all of its bonds or obligations shall become or may be declared due before maturity, and as to the terms and conditions upon which such declaration and its consequences may be waived.

(10) To vest in a trustee, or the holders of bonds, or any proportion of them, the right to enforce the payments or the bonds or any covenants securing or relating to the bonds; to vest in a trustee the right, in the event of a default by the Authority, to take possession and use, operate and manage any real property and to collect the rents and revenues arising therefrom and to dispose of such moneys in accordance with the agreement of the Authority with said trustee; to provide for the powers and duties of a trustee and to limit liabilities thereof; and to provide the terms and conditions upon which the trustee or the holders of bonds, or any proportion of them, may enforce any covenant or rights securing or relating to the bonds.

(11) To prescribe by whom and on whose behalf proceedings may be commenced in law or in equity in any court of competent jurisdiction to complete performance or compliance with covenants and undertakings by the Authority.

(12) To exercise all or any part or combination of the powers herein granted; to make covenants other than, and in addition to, the covenants herein expressly authorized; to make such covenants and to do any and all such acts and things as may be necessary to convenient or desirable in order to secure its bonds or, in the discretion of the Authority, as will tend to accomplish the purposes of this act, by making the bonds more marketable notwithstanding that such covenants, acts or things may not be enumerated herein.

(d) Bonds as securities. The bonds, notes and obligations authorized herein are hereby made securities in which all state and municipal officers and administrative departments, boards and commissions of the Commonwealth; all banks, bankers, saving banks, trust companies, savings and loan associations, investment companies and other persons carrying on a banking business; all insurance companies, insurance associations and other persons carrying on an insurance business; and all administrators, executors, guardians, trustees and other fiduciaries; and all persons whatsoever who now or may hereafter be authorized to invest in bonds or other obligations of the Commonwealth, may properly and legally invest any funds, including capital, belonging to them or within their control, and the bonds, notes or other obligations are hereby made securities which may properly and legally be deposited with and received by any state or municipal officer or agency of the Commonwealth, for any purpose in which the deposit of bonds, notes or other obligations of the Commonwealth is now or may hereafter be authorized by law.

Section 8. Preemption; sole and exclusive determination of the need for a high speed intercity rail passenger system. The General Assembly hereby expressly mandates, based on its findings, that high speed intercity rail lines are needed in order to effect the public purposes of this act and that this act is the sole and exclusive determination of need for any high speed intercity rail line established pursuant to this act, thereby preempting the determination of need and necessity of assessing or weighing need with the impacts of any such lines.

Section 9. New and improved services. It shall be the duty of the Authority, as promptly as possible, to rehabilitate, reconstruct and extend, as possible, all portions of the system operated by the Authority and maintain at all times a fast, reliable and economic system suitable and adapted to the needs of the people of the Commonwealth served by the Authority and for safe, comfortable and convenient service. To that end, the Authority shall make every effort to utilize high speed intercity rail technology. The high speed intercity rail passenger service may be improved when that is consistent with its operation. In particular, the Authority has responsibility for coordinating feeder services carrying passengers to or from the Commonwealth's high speed intercity rail passenger system.

Section 10. Exemption from Taxes and Assessments. The effectuation of the authorized purposes of the Authority created under this act shall and will be in all respects for the benefit of the people of the Commonwealth, for the increase of their commerce and prosperity, and for the improvement of their safety, health and living conditions. Because the Authority shall be performing an essential government function in effectuating such purposes, the Authority shall not be required to pay any taxes or assessments upon any property acquired or used by and for such purposes, or fees or other charges imposed or authorized to be imposed by virtue of any law of the Commonwealth. If at their issuance, the Authority has in its discretion so determined, bonds issued by the Authority shall be free from taxation other than inheritance and estate taxation within the Commonwealth.

Section 11. Eminent domain. The Authority may acquire by exercise of the power of eminent domain any lands, interests in land, property right, rights-of-way, franchises, easements or other property as it deems necessary, useful or convenient to carrying out the purposes of this Act. When the property being acquired is owned or used by the National Railroad Passenger Corporation or Consolidated Rail Corporation, the acquisition and subsequent use and operation by and for the Authority (a) shall not cause any material or unnecessary interference with safe and efficient operations or the provision of services by either of those entities, and (b) shall not require either of those entities to bear any liability or exercise any increased duty of care to, for, or on account of (i) the high speed intercity rail passenger services performed by or for the Authority, or (ii) any persons or property performing or being carried on such services. The Authority shall exercise the power of eminent domain in the manner prescribed by the act of June 22, 1964, (P.L. 84).

Section 12. Government and private interests.

(a) The Authority is directed to administer its responsibilities with such flexibility as to permit full cooperation between Federal, state and local governments, agencies and

instrumentalities as well as private interest and so as to result in as effective and economical a system as possible.

(b) The Authority is hereby authorized to enter into agreements providing for mutual cooperation between or among it and any Federal agency, local transportation organization, or transportation company, including joint applications for Federal grants. To enter into mutually agreeable contracts concerning the owning, leasing, managing and operating of track currently owned by either the National Railroad Passenger Corporation or Consolidated Rail Corporation but required or necessary, thereby allowing the immediate operation of service by the Authority.

(c) It is the purpose of this act to authorize the Authority to do any and all other things necessary or desirable to secure the financial aid or cooperation of any Federal agency and to do and perform all the lawful requirements of any Federal agency authorized to administer any program of Federal aid.

Section 13. Labor contracts. The Authority shall deal with and enter into labor contracts with employees of the Authority in accordance with the Act of July 23, 1970 (P.L. 563).

Section 14. Inconsistent law. It is the intent of the General Assembly that, if there is any conflict or inconsistency in the provisions of this act and any other acts pertaining to matters herein established or provided for, or in any rules and regulations adopted under this act or other acts, or in local rules, regulations or ordinances, to the extent of the conflict or inconsistency, the provisions of this act and the rules and regulations adopted hereunder shall be enforced and the provisions of the other acts and rules and regulations adopted thereunder shall be of no effect.

Section 15. Appropriations; organizational and administrative costs. To provide for the organizational, administrative and other costs incident to the inception and early operations of the Authority, including, without limitation, any expenses necessary or incident to determining the feasibility or practicability of any projects, such sums as are necessary are hereby authorized to be appropriated from the General Fund.

Section 16. Effective date. This act shall take effect upon enactment.

APPENDIX B

CONSULTANTS

The General Engineering Consultant for the project was the joint venture known as Parsons Brickerhoff Gannett Fleming, consisting of Parsons Brinckerhoff Quade & Douglas of Philadelphia and New York City, and Gannett Fleming Transportation Engineers of Camp Hill. Subconsultants to PBGF and their fields of study were:

John Bachman -- vehicle technology
The Budd Co. -- magnetic levitation technology
Dechert Price & Rhoads -- legal and institutional issues, ownership, operations and local coordination
Ernst & Whinney -- economic impact policy and investment and financing
Gibbs & Hill, Inc. -- power systems, signal and communications systems
John T. Harding -- magnetic levitation technology
Opinion Research Corp. -- market demand surveys
Prudential-Bache Securities -- public and private financing options
Sofrerail -- vehicle technology
Westmoreland Engineering Co., Inc. -- right-of-way and bridges
D. S. Winokur Associates -- alignment graphics

The Oversight Consultant for the project was STV Engineers of Pottstown, PA., and New York City. Its subconsultants were:

R. L. Banks and Associates
Daniel, Mann, Johnson and Mendenhall

Railroads providing data, track charts and other support were Amtrak, Conrail, SNCF (French National Railroads), Deutsche Bundesbahn (German Federal Railways), and Japanese National Railways.

APPENDIX C

INVENTORY OF REPORTS

Following is a tally of reports filed with the commission by the general engineering consultant and subconsultants, along with some of the major documents used in the preparation of those reports. They are listed here chronologically.

- Preliminary Estimate of Economic Impacts, Memorandum Report C, November 1983
- Definition of Study Area and Methodology, Memorandum Report A, December 1983
- Preliminary Financing Scenarios, Memorandum Report D, January 1984
- Preliminary Alignment Candidates, Memorandum Report H, January 1984
- Preliminary Institutional Scenarios, Memorandum Report, January 1984
- Demand Estimating Methodology, Memorandum Report B, February 1984
- Cost Estimating Procedures and Preliminary Unit Costs, Memorandum Report E, February 1984
- Station Inventory and Preliminary Development Opportunities, Memorandum Report F, undated
- Environmental Requirements, Memorandum Report J, April 1984
- Executive Summary, Phase 1, February 1985
- Preliminary (Technical) Report, Phase 1, February 1985
- Turnpike, Rail and Airline Surveys Conducted in May and June of 1985, Memorandum Report, July 1985
- Market Research Surveys, Memorandum Report, October 1985
- Documentation of Alignment Studies, Greensburg to Pittsburgh, Westmoreland Engineering Co., Inc., October 1985
- Alignment Studies, Technical Memorandum, December 1986
- Market Demand, Executive Summary, July 1986
- Market Demand, Technical Memorandums, July 1986
- Maintenance Facilities, Technical Memorandum, July 1986
- Station Development, Technical Memorandum, December 1986
- Costs and Revenues, Technical Memorandum, January 1987
- Standard Guidelines for Revenue and Ridership Forecasting, High Speed Rail Association
- Draft Legislation, May 8, 1987

APPENDIX D

LEGISLATIVE HISTORY OF HIGH SPEED RAIL

This is a listing of all legislative votes specifically dealing with high-speed rail. It excludes annual budget votes.

House Bill 2231 of 1980-81 Session

- Authorizing Pennsylvania's participation in Midwest-Northeast high speed rail compact (with Ohio, Michigan, Indiana and Illinois). Referred to committee 2/5/80.
- Voted out of committee 2/25/80.

HOUSE

- 174-0 vote. Final passage 3/26/80.
- 176-0 vote. Concurrence in Senate amendments 6/9/80.

SENATE

- Amended in Transportation Committee 5/6/80.
- 49-0 vote. Final passage 5/28/80.
- Signed into law as Act 75 of 1980.

House Bill 305 of 1980-81 Session

- Creating High Speed Intercity Rail Passenger Commission -- listing powers and duties, length of life (five years) and making an $850,000 appropriation. Referred to committee 1/27/81.
- Voted out of committee 3/17/81 with amendments. Amended in Appropriations Committee 6/8/81.

HOUSE

- 190-4* vote. Final passage 6/23/81 (Voting "nay" were Reps. Lewis, Heiser, Marmion and Serafini).
  *Rep. Serafini later that day officially asked the Speaker to change his vote to "yea".
- 184-0 vote. Concurrence in Senate amendments (Reps. Heiser, Marmon and Serafini cast "yea" votes).

SENATE

- Voted out of Transportation Committee 6/24/81, amended in Appropriations Committee 11/16/81.
- 47-0 vote. Final passage.
- Signed into law as Act 144 of 1981.

House Bill 1832 of 1983-84 Session

- Appropriating $2.9 million (referred to committee 12/14/83).
- Voted out of committee 1/23/84.

HOUSE

- 198-0 vote. Hutchinson amendment (drafted by Thornburgh Administration) to require referendum. Voted on 2/22/84.
- 197-0 vote. Final passage, same day. (Two members who did not vote asked to be placed on record as being favorable had they been at their desk.)
- 182-0 vote. Concurrence in Senate amendments 4/24/84.

SENATE

- Kusse amended in committee 3/19/84 to lower appropriation to $1.6 million, to strike the Hutchinson amendment and to make the appropriation coincide with the customary state budget cycle.
- 45-0 vote. Final passage 3/28/84.
- Signed into law as Act 3A of 1984.

House Bill 2594 of 1985-86 Session

- Extending sunset provision of commission by two years. Referred to committee 6/10/86.
- Voted out of committee 6/17/86.

HOUSE

- 198-0 vote. Final passage 10/17/86.
- 194-0 vote. Concurrence in Senate amendments 11/25/86.

SENATE

- Amended by Corman in committee to cut back sunset provision to one year and to establish a legislative oversight committee. Voted out of committee 11/17/86.
- 49-0 vote. Final passage 11/19/86.
- Signed into law as Act 190 of 1986.

RECAPITULATION: 13 votes, 12 of which were unanimous.

APPENDIX E

HISTORY OF THE COMMISSION

During the early 1980s, the concept of building high-speed rail systems in America began to gain momentum. In Pennsylvania, this idea was conceived with a dual purpose -- to strengthen the state's economy through building its employment and technology base, and to provide fast, safe and reliable ground travel for millions. The Pennsylvania MILRITE (Make Industry and Labor Right in Today's Economy) Council endorsed the concept of Pennsylvania becoming a leader in the United States for high-speed intercity rail passenger travel by building a new railroad with trains running at well over 100 mph in the Philadelphia-Harrisburg-Pittsburgh corridor.

Two state House members, Rep. Richard A. Geist (R-Altoona), a member of the MILRITE Council, and Rep. Joseph Kolter (D-New Brighton) wrote legislation in January 1981 to form the High Speed Intercity Rail Passenger Commission. The bill, H.B. 305, gained cosponsorship of 141 of the House of Representative's 203 members.

The nine-member commission's duties and powers were spelled out in the legislation, which gave the commission "overall responsibility, power and duty to investigate, study and make recommendations concerning the need for the establishment and operation of a high speed intercity rail passenger system in the Commonwealth."

Named commission legislative members were Reps. Geist and Kolter and Sens. Robert C. Jubelirer (R-Altoona) and James E. Ross (D-Beaver). The other five members, named by Gov. Dick Thornburgh, were as follows: rail labor representative, Everett W. Croyle of Enola, the United Transportation Union's state legislative director; industry representative, Richard C. Sullivan of Villanova, a vice president of Conrail; executive branch representative, Kant Rao of Harrisburg, deputy secretary of the budget; and public interest representatives, Robert A. Gleason Jr., a Johnstown insurance executive and secretary of the Commonwealth, and Robert A. Patterson of State College, vice president and treasurer of Pennsylvania State University.

In January 1983, Mr. Kolter became a member of Congress. He was succeeded on the commission by Amos Hutchinson (D-Greensburg), chairman of the House Transportation Committee.

House Speaker Matthew J. Ryan presided over the election of officers. Rep. Geist was chosen chairman; Sen. Ross, vice chairman, and Representative Hutchinson, secretary.

Dr. Robert J. Casey of Pittsburgh was hired by the commission January 12, 1983, as executive director. Dr. Casey began his duties February 14, 1983. He was formerly executive director of the Ohio Rail Transportation Authority, public information director of Amtrak, executive director of the National Association of Railroad Passengers, and public relations director of Westinghouse Air Brake Company (WABCO).

Other staff members were Eric Bugaile, assistant director; Daniel Cupper, executive editor; and Dorothy Ketner, executive secretary.

Early in 1983, the commission was awarded a $200,000 grant by the Federal Railroad Administration to aid in the project feasibility study. Soon afterward, the commission began its search for an engineering consultant to conduct the study. The commission's "Request for Proposal" drew responses from more than 50 firms.

More than 30 firms joined forces in four separate consortiums to make proposals to the commission on June 28, 1983. Parsons Brinckerhoff/Gannett Fleming (PB/GF), a joint venture of two engineering giants along with assistance from a dozen subcontractors, was chosen by the commission as consultant for the $2.3 million study.

Soon after the general consulting consortium was chosen, the commission chose STV Engineers, Inc. to act as oversight consultant for the feasibility project. STV and its associated subcontractors were charged with reviewing all data submitted by the general consultants for accuracy and reliability.

The PB/GF team presented its Phase 1 report to the commission on February 12, 1985, and work began immediately on Phase 2.

From March 27 through April 8, 1985, commission members and staff traveled through West Germany, France and Great Britain to inspect the high-speed trains of Europe, riding more than 3,000 miles by rail in nine days. The group rode the West German TR-06 experimental magnetic levitation train, the French TGV (*Train A Grande Vitesse*, or Very High Speed) 168 mph Paris-Lyons express, and the British Rail high-speed diesel train, the Inter-City 125, as well as a number of other European trains.

One April 17, 1985, Sen. J. Doyle Corman (R-Bellefonte), chairman of the Senate Transportation Committee, became a member of the commission to replace Sen. Jubelirer, who resigned, citing new duties as senate president *pro tempore*.

The commission decided at its May 27, 1985, meeting to drop from further consideration the so-called Alternative C, the slowest (120 mph) option presented by the consultants as a result of work in Phase 1. The commission instead decided to continue its study based on Alternative D (160-to-180 mph service) and Alternative E (250 mph service using magnetic levitation technology).

On May 29, 1985, Federal Railroad Administrator John H. Riley announced at the Second International Convention on High Speed Rail that Pennsylvania would receive a $140,000 grant to aid in the feasibility study.

On September 9, 1985, the Commission received a grant of $25,000, plus in-kind services worth over $100,000 from the West German Ministry for Research and Technology, to aid in the Commission's study of magnetic levitation.

In July 1986, the Commission released the results of its year-long $425,000 ridership and market survey, the first to be conducted in accordance with demand forecasting standards drawn up by the High Speed Rail Association. The study projected that, by the year 2000, between 5.5 million and 8.8 million passenger annually would ride high speed rail in the Pennsylvania Corridor.

In 1986, the Commission's life was extended to December 31, 1987. The consultant team was starting work on the final segments of the study when all funding was abruptly terminated. The Commission continued to meet formally until legislative sunset, and authorized completion of the study by staff, based on the data produced by the consultants. Commission Chairman Geist arranged for a $44,000 grant from the Federal Railroad Administration for production of the Final Report. Pennsylvania Secretary of Commerce Raymond Christman wrote to the FRA on November 18, 1988, to request the grant. After a further delay while the contract was being amended, he signed the contract on February 13, 1989 and Federal Railroad Administrator Riley signed it February 14, 1989.

APPENDIX F

TRANSRAPID INTERNATIONAL PROPOSAL

CONTENTS:

1. Introduction and Summary

The MagLev routing proposed by the consultants for Philadelphia to Pittsburgh is very expensive. A fine rail system already exists between Philadelphia and Harrisburg. From Harrisburg to Pittsburgh the routing proposed by the consultants did not take advantage of the MagLev grade climbing capability and included many expensive tunnels.

Transrapid International has studied an all-MagLev Route from Harrisburg to Pittsburgh that eliminates tunnels and takes advantage of the MagLev grade climbing and speed capability.

It has been determined that a single track system between Pittsburgh and Harrisburg with two 25 mile passing sidings and eight six-section trains could provide hourly service with the capacity of 600 passengers each direction and with running times of approximately 1 hour 28 minutes including stops at Greensburg, Johnstown, Altoona, State College and Lewistown (alternate route) for a capital cost of approximately $2.8 to 3.0 billion.

It is recommended that a 250-300 mph MagLev system be considered for the Harrisburg - Pittsburgh link of a cross state system with an up-graded rail system, initially from Philadelphia to Harrisburg.

The sections that follow in the report describe the characteristics of the Transrapid MagLev System, the routing between Pittsburgh and Harrisburg, the computer simulations and cost, and the conclusions and the recommendations.

2. Characteristics of the TRANSRAPID Maglev System

A shift in traffic back to tracked transport systems is a generally accepted aim for reasons of "environment" and "conservation of energy resources". But also the frequency of road accidents, as well as the increasing density of air traffic, together with a large number of close collisions and catastrophes, make the aim of safer, land-bound transport systems seem more than sensible.

However, the shift from road and air traffic to tracked systems can only be achieved if fundamentally new technologies are applied that permit considerably reduced travelling times.

The TRANSRAPID maglev system with a speed of 250 mph (400 km/h) and more has the very qualities required to achieve the above-mentioned effects of a shift in traffic.

Apart from a top speed of over 400 km/h, maglev has a number of other specific advantages.

Absolutely derail proof on account of its wrap-around undercarriage which locks the Maglev cars to the guideway (see Fig. 1).

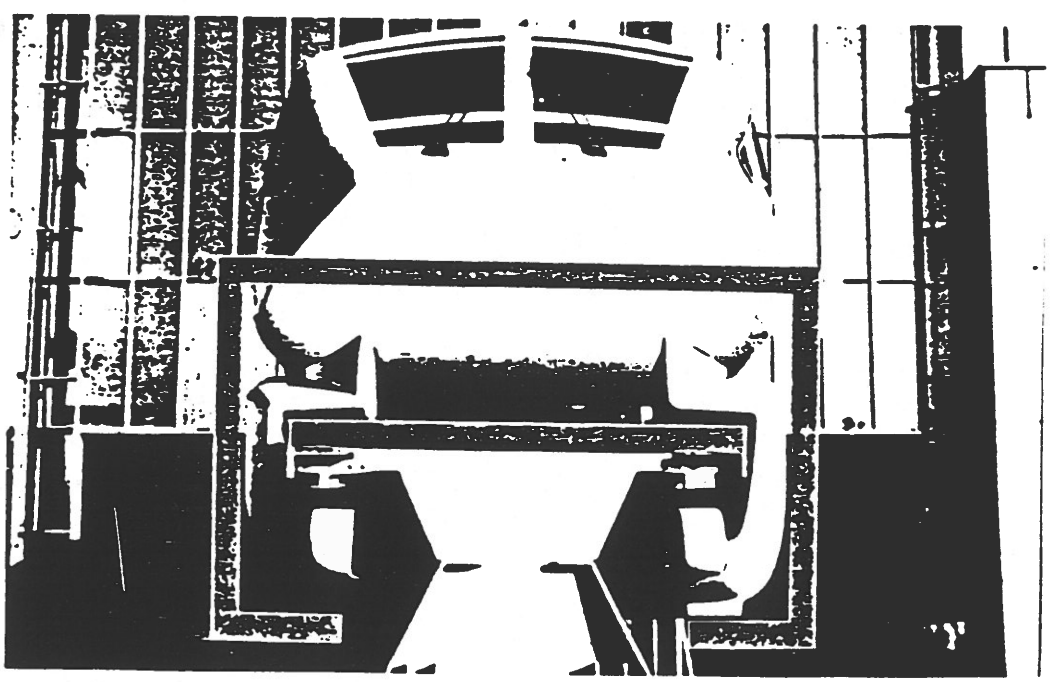


Fig. 1: Derail Proof of Transrapid

The non-contacting levitation, guidance and propulsion system guarantees a high degree of riding comfort at low noise levels, as well as operation which is largely free of wear.

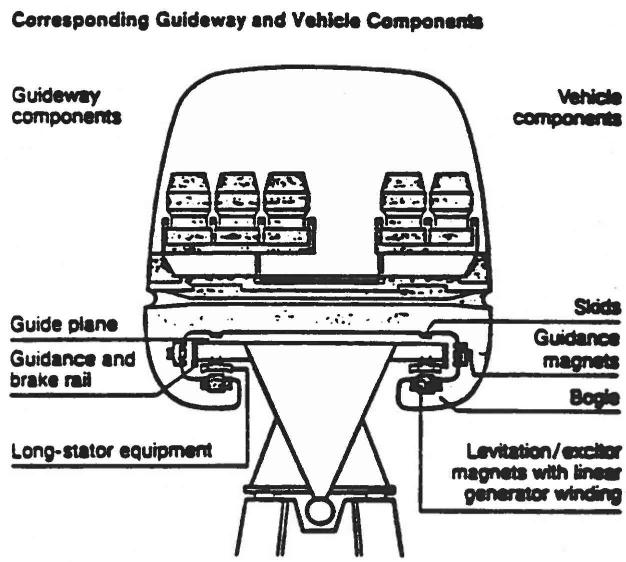


Fig. 2: *Levitation, Guidance and Propulsion System*

The long-stator linear drive with its components installed in the guideway (see Fig. 3) and stationary installations has the advantage of specific dimensioning of sections of line in keeping with local requirements. This means that on stretches where the vehicle starts off or brakes, the drive can be reinforced locally. Thus, short acceleration and braking times are also possible in difficult terrain. Similarly, on steep gradients speed losses are avoided.

A substantial advantage of the long-stator linear drive is its ability to climb steep gradients. This advantage, especially in topographically difficult terrain, as in the present case between Pittsburgh and Harrisburg, offers excellent routing possibilities. Although no limit has been fixed in theory, a maximum gradient of 10% has proven adequate for routing in practice.

This ability to climb gradients, which is far greater than that of conventional wheel-on-rail systems, means that the construction of tunnels and large bridges spanning valleys can be reduced or even avoided.

This is one of the reasons why capital expenditure on a maglev system in difficult terrain is less than on conventional tracked transport systems.

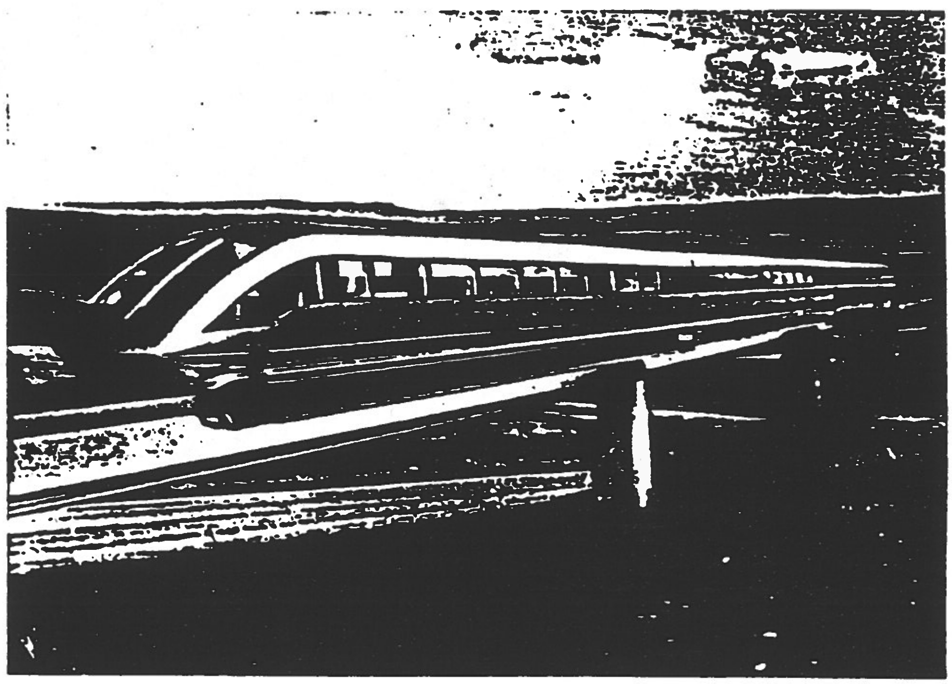


Fig 4: *TR06 II*

Maglev vehicles contain no active drive elements and are, therefore, particularly light. This, in turn, means considerably reduced operating loads on the guideway, permitting a favorably priced construction.

There are different concepts for the maglev guideway. Constructions on ground level and elevated constructions are possible.

The elevated steel and concrete guideways are supported by columns normally at a height of approximately 5 m.

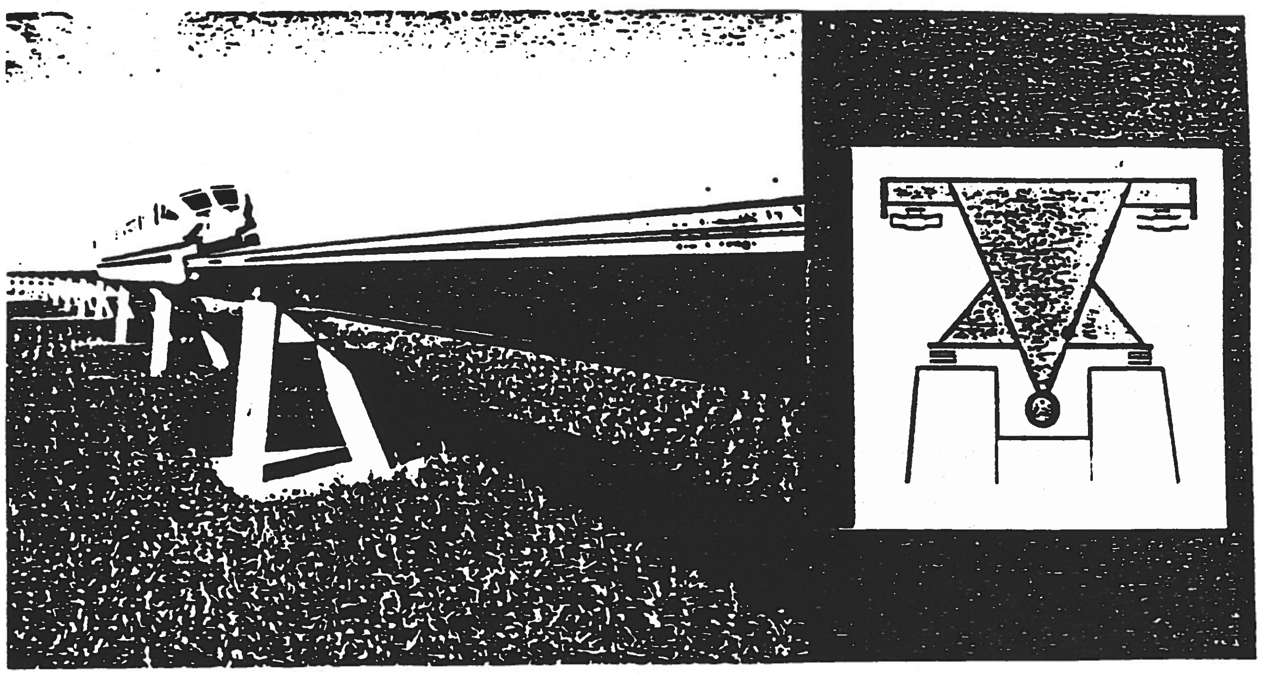


Fig. 5: Elevated Steel Guideway

The elevated guideway has the advantage of taking up less space and of not carving up the landscape, such as is frequently the case with conventional wheel-on-rail-systems. Existing infrastructure (e.g. farming, see Fig. 6) is affected only minimally.

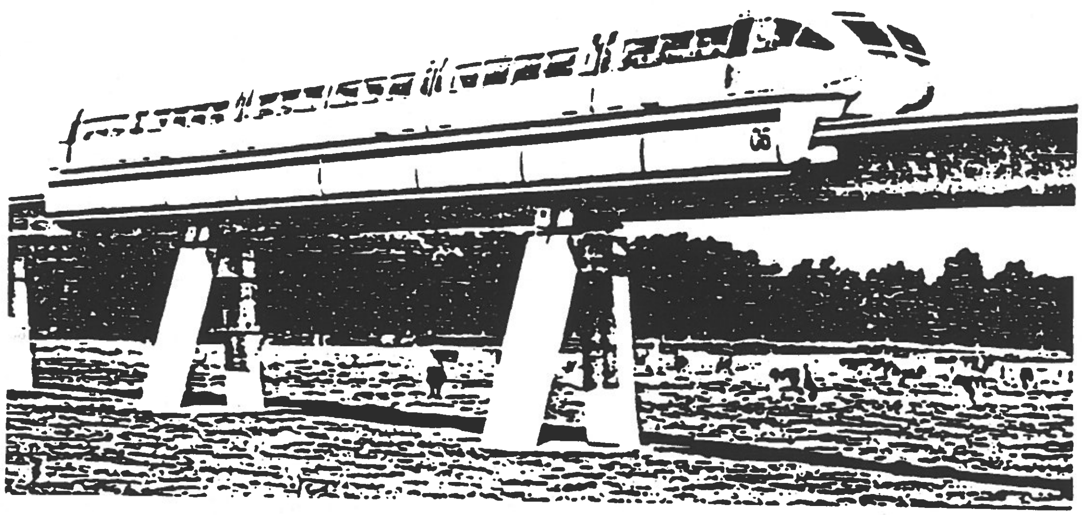


Fig. 6: Elevated Concrete Guideway

3. Routing

3.1 Starting Situation

The consultants Parsons Brinckerhoff planned an alignment between the two points to be connected: Pittsburgh and Harrisburg. The aim was to join the urban areas of Pittsburgh, Greensburg, Johnstown, Altoona, State College and Harrisburg with a high-speed tracked transport system, and to reduce the travelling time that has been required so far.

However, the planned line location was one-sided, being wheel-on-rail-oriented. It did not take account of the advantages of the maglev system, such as its ability to cope with steep gradients and, thus, its greater adaptability to the terrain. The drafted route in the ground plan required a disproportionately large and expensive section of tunnel for the total track length of about 390 km.

Therefore, Transrapid International planned a maglev route, connecting exactly the same points, as an alternative.

The system is single tracked with two passing sidings (25 miles / 40 kilometers) which allow hourly service in each direction for six section trains (up to 600 passengers/hour/direction).

Preparations for a later extension to a double track system are provided (grading and foundations).

One of the main aims when planning the line location was to adapt the route in the ground plan stage to the topography in such a way as to entirely avoid sections of tunnel by taking advantage of maglevs ability to climb steep gradients.

For this purpose, the high and steep mountain ridges that frequently had to be crossed were approached at an angle. This resulted in a long-stretched-out line with continuous stretches of ascent and descent. This routing method increases the total line length between Pittsburgh and Harrisburg by about 10%, but with this draft route the maglev vehicle can keep up a speed of 400 km/h (250 mph) over a stretch of 290 km.

A further advantage of this line location is that the higher hills can be crossed with normal elevated constructions (< 10 m above the terrain). Thus, the landscape is not carved up by high embankments and cuttings, as is the case with the wheel-on-rail system.

Use of the elevated quideway also minimizes the number of constructions at crossing which are otherwise required at traffic intersections.

3.2 Planning the Route

A comprehensive computer program, specially developed for the maglev system by Transrapid International, was used to work out the route. Apart from the three-dimensional route design, this program dimensions the long-stator linear drive, calculates travelling time and energy consumption, and determines capital expenditure.

The line location in the ground plan was drafted graphically in the topographical maps in a scale of 1:24000. Afterwards, data on the terrain and the position and type of traffic intersections along the route were determined digitally.

Longitudinal profiles were then plotted by the computer program and the route drafted in a vertical section. The route elaborated in this way can then be optimized according to different criteria by means of computer. In addition, a journey along this route can be simulated by the computer.

3.3 Line Location

A short description of the Maglev route is given below.

The detailed horizontal and verical layout of the route is added as annex.

3.3.1 Pittsburgh - Greensburg (km 0 - 56)

The maglev line leaves the city area in Pittsburgh (Central Station) along the railroad track beside the Allegheny River, travelling east.

After crossing Plum Creek the route turns southeast, crosses the William Penn Highway south of Export and then reaches Greensburg directly from the north.

For the station at Greensburg there is also mentioned an alternate station outside the downtown area.

In this low mountain landscape the gradient is generally high elevated.

3.3.2 Greensburg - Johnstown (km 56 - 119)

Following the railroad track Greensburg - Latrobe, the planned maglev route leaves Greensburg, travelling northeast. After crossing Chestnut Creek and Conemaugh River east of Blairsville, the track rises over Chestnut Ridge.

Chestnut Ridge is crossed south of the Penn View Mountain with a gradient of approximately 7%.

Then, travelling along the Conemaugh River through the ridge of Laurel Hill, the maglev track reaches Johnstown. The extremely steep terrain around West Taylor, shortly before Johnstown, can be traveled over with small radii both in the ground and vertical plan because of the low speed in the stopping area. Thus, gradients of 10% can be implemented in the maglev line.

3.3.3 Johnstown - Altoona (km 119 - 174)

The maglev line leaves Johnstown directly eastwards. Via Portage, Cresson and Galitzin, the route follows the Kittmanning Reservoir and Lake Altoona before reaching Altoona.

In this section between Johnstown and Altoona the gradient can be very well adapted to the extremely undulating terrain by taking advantage of the maglevs great ability to climb.

The guideway is largely elevated.

3.3.4 Altoona - State College (km 174 - 234)

Shortly after leaving Altoona, the Brush Mountain range running from southwest to northeast has to be crossed. At the same time, the nature reserve of Sinking Valley should be avoided.

Thus, the maglev route is on the northwest of the Brush Mountain range via Bellwood to Tyrone.

Then the ridge of Bald Eagle Mountain is crossed diagonally.

In the valley area between Rothrock State Forest and The Barrens, maglev then reaches State College.

3.3.5 State College - Harrisburg (km 234 - 387)

The most difficult part of the entire route between Pittsburgh and Harrisburg is crossing the mountains around the Bald Eagle State Forest. A solution is to place the line along the Penn Valley via Tussyeville to Potters Mills. After a short stretch parallel with the US Route 322 going south from Potters Mills, the maglev line rises steadily along the contour to the 1840 foot high Faust Valley. Via Little Poe Valley and the saddle on Long Mountains, the route then descends steadily via Panther Hollow to Penns Creek.

Along the valley floor of Penns Creek the maglev line reaches the end of the valley near the location of Penns Creek.

From here the route runs directly southward. After touching on Middleburg, the foothills of Shack Mountain are bypassed parallel to State Route 104.

The maglev route reaches the Susquehanna River via Mount Pleasant and Liverpool.

Along the west side of the Susquehanna River the maglev route bypasses the ridges of Buffalo Mountain and Berry Mountain.

West of Halifax the maglev line crosses the river via Clemson Island and, passing through hills south of Halifax, reaches the ridge of Peters Mountain.

The maglev route crosses this ridge diagonally.

In a wide curve the route turns towards the William Penn Highway and the railroad track to Harrisburg.

Along these existing traffic axes, passing Wildwood Lake, the maglev train reaches its provisional destination in Harrisburg City.

3.3.5.1 Alternate Lewistown (km 0-90)

The Lewistown Alternate enters the mountains about 2 km North of Potters Mills and continues on a 4000 m curve (about 180°) through Synagogue Gap, across Sand Mountain and Long Mountain, and Front Mountain to Milroy. Thence southeast on the south side of Rt. 322 to the gap in the Jacks Mountain.

Route then parallels Rt. 322 to Lewistown Station, located between Rt. 322 and Kishacoquillas Creek. Route then follows the North side of Shade Mountain from Lewistown to near Beavertown and crosses over to rejoin route near Mt. Pleasant Mills.

4. Travel time, energy, cost

The journeys of a six section maglev vehicle along the two routes described above were simulated in the computer. This computer simulation provided electric characteristic data and the necessary dimensions for the long-stator drive.

The travelling time and energy consumption are also calculated.

The main results of the simulation are figured in enclosure 4 of the Annex for the whole track length.

At this point is is important to mention energy consumption of approx. 13 MWh at a travelling time of 1 h 27 min 40 sec (including 4 stops, 2 minutes each) for the main route and 1 h 29 min 30 sec (including 5 stops, 2 minutes each) for the Lewistown alternative.

However, it is possible to reduce the energy consumption by optimizing the travelling profile with the same travelling time. By travelling more slowly on upward and more quickly on downward slopes, energy consumption can be reduced significantly.

Capital expenditure on the entire system, that means single track guideway incl. two passing sidings and 8 six section vehicles, is estimated as follows:

A = Pittsburgh - Harrisburg
B = Pittsburgh - Harrisburg via alternate station Greensb.
C = Pittsburgh - Harrisburg via Lewistown
D = Pittsburgh - Harrisburg via alternate station Greensb. and alternate route Lewistown

	A	B	C	D
Line capital costs (Million $)	1,755.9	1,718.4	1,885.8	1,849.2
System length km	387.35	382.08	394.09	388.02
Cost/km	4.533	4.498	4.785	4.776
Vehicles	165.6	165.6	165.6	165.6
Stations	81.2	81.2	94.7	94.7
Maint. Facilities	123.1	123.1	123.1	123.1
Subtotal	2,125.8	2,088.3	2,269.2	2,232.6
Design & Constr. Mgmt 12%	255.1	250.6	272.3	267.9
Subtotal	2,380.9	2,338.9	2,541.5	2,500.5
Congingency 20%	476.2	467.8	508.3	500.1
Total Costs	**2,857.1**	**2,806.7**	**3,049.8**	**3,000.6**

5. Conclusions and recommendations

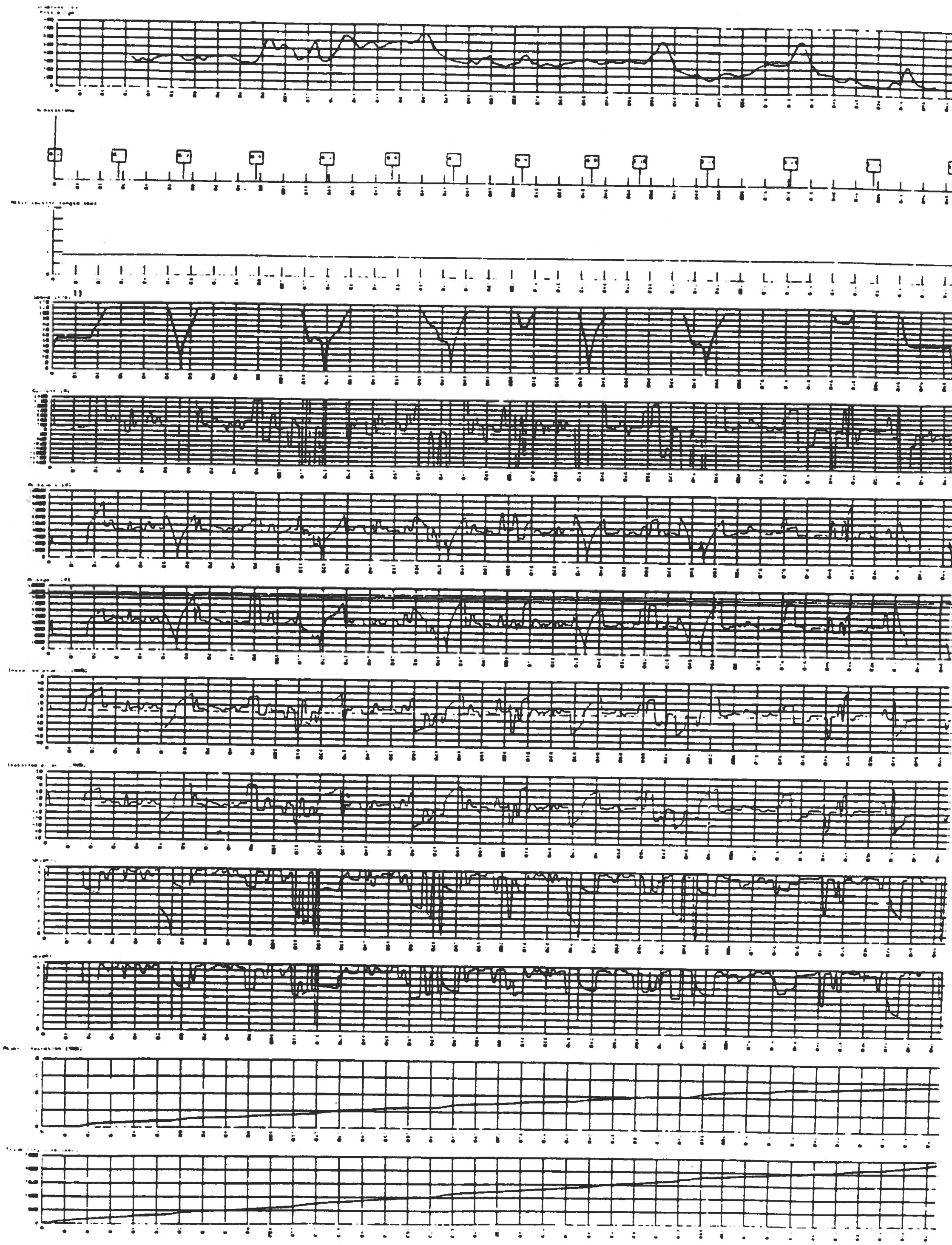
The TRANSRAPID maglev system can bring about the desired shift of road and air traffic to tracked transportation because of its high top speed of over 250 mph (400 km/h).

Due to the systems special characteristics resulting primarily from the non-contacting levitation, guidance and propulsion system, maglev is not only faster but also more favourably priced than a conventional wheel-on-rail system.

The study has demonstrated that a Maglev link between Pittsburgh and Harrisburg without tunnels is feasible.

Especially when applied in difficult terrain, such as between Pittsburgh and Harrisburg, the ability to climb steep gradients up to 10% leads to great benefits.

Longstator Propulsion Layout



Pennsylvania Study

Pittsburgh – Harrisburg incl. Lewistown / 6 Section Vehicle
Longstator Propulsion Layout

1) 110 m/s ≙ 250 mph